UNIVERSITY OF Southampton

July 2019

ADVANCING LIFE SCIENCES

Institute for Life Sciences

Spotlight on:
Pioneering research enabled by disruptive technologies

News and features:
Researching biofilms in infant feeding tubes

Publications:
A sample of research outputs from our PhD students

FOUNDING MEMBER OF THE RUSSELL GROUP

WELCOME

Life Sciences are essential to our wellbeing, the economy and the protection of an environment critical to our survival. The Life Sciences community at the University of Southampton is at the forefront of approaches to address these global challenges, breaking the traditional mould of solving problems within the confines of a discipline.

We have an established reputation for working collaboratively, by taking disruptive approaches and risk through interdisciplinary team science. With interdisciplinary culture at the heart of our community, we focus on four areas of excellence: Health and Medicine, and Living Systems, alongside Disruptive Life Technologies and Insights through Data. The latter provide the advanced tools to drive our understanding at the frontiers.

In previous reports, we have focused on the expansion of our impact in regional activities and how we have contributed to government strategy. In this report, we continue to highlight our impact through our engagement with The Rosalind Franklin Institute and The Alan Turing Institute, as well as showcasing our current collaborations, technological breakthroughs and demonstrating the increasing importance of data in all of our research.

You can also see a selection of recent publications from our cohort of interdisciplinary PhD students as they develop into independent researchers and future leaders.

Professor Peter JS Smith
Director of the Institute for Life Sciences

The Life Sciences are a key component of the UK strategy for growth, underpinning our engagement with health and the biosciences here at the University of Southampton.

This year's report from the Institute for Life Sciences (IfLS) highlights the central role it continues to play in terms of our institutional aspirations and achievements, as a dynamic, consistent and collaborative champion of our life sciences portfolio.

Professor Mark Spearing
President and Vice-Chancellor (Interim)
University of Southampton

Front cover image: First-of-a-kind soft tissue-optimised micro-computed tomography (µCT) scanner in Southampton for 3D X-ray histology.

Find out more:
www.southampton.ac.uk/ifls

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PIONEERING RESEARCH ENABLED BY DISRUPTIVE TECHNOLOGIES

Southampton is renowned both nationally and internationally for the strength and breadth of its interdisciplinary life sciences research, and is particularly proud of its revolutionary collaboration between medical, health and natural sciences.

From identifying indicators to predict accelerated ageing, to using mathematical modelling to understand breast cancer, and from developing high resolution microscopy tools to using chemistry processes to create new antibiotics, Southampton's life sciences portfolio spans many areas across the University.

The global recognition of the University as a hub of expertise in the life sciences has led to the organisation becoming a partner of two leading UK institutions that are pioneering research – The Rosalind Franklin Institute and The Alan Turing Institute.

Southampton's involvement

The University's Institute for Life Sciences Director and Board Member of The Rosalind Franklin Institute, Professor Peter JS Smith, strongly welcomes Southampton's involvement in these two innovative institutions.

He said: "It is a great pleasure to become a core part of these two major institutes. It reflects the strength we have in life sciences research across many disciplines.

"At Southampton, we are capable of contributing to a number of the core themes of The Rosalind Franklin Institute, particularly with our research in disruptive advances in imaging technologies from the large scale down to the atomic scale.

"We will feed into projects that The Rosalind Franklin Institute is undertaking and will be at the forefront of cutting-edge technology development that will help drive our own research forward."

The Rosalind Franklin Institute

The Rosalind Franklin Institute is dedicated to transforming life science through interdisciplinary research and technology development. It aims to produce technologies that will allow us to see the biological world in new ways, from single molecules to entire systems, speeding up drug design and development, and pushing forward our understanding of human health and disease.

The University of Southampton is one of ten universities at the core of The Rosalind Franklin Institute, who will work with industrial and academic partners to foster interdisciplinary research, at scale, with real impact.

The Alan Turing Institute

The Alan Turing Institute is the UK's national institute for data science and artificial intelligence. Its goals are to undertake world-leading research in these areas, apply this research to real world problems, drive economic impact and societal good, lead the training of a new generation of scientists, and shape the public conversation around data. Several members of the IfLS are now Turing Fellows with access to opportunities and the wider network.

Image: Extreme ultraviolet light generated by femtosecond lasers is used by Professor Jeremy Frey and Dr Bill Brocklesby for nanoscale imaging of neurons.

Cross-Institute Engagement

Here we look at how some of our researchers are taking disruptive approaches to solve life science questions.

Using mathematical modelling in predicting breast cancer

Dr Philip Greulich is one of the University's first Turing Fellows and is investigating how stem cells divide and differentiate, which is crucial for understanding how cancer develops.

Collaborating with Dr Salah Elias, also from the IfLS, Philip is using mathematical modelling tested on Salah's experimental data, to explore whether the direction in which breast tissue cells divide, can determine the cell fate and what type of cell it will become.

He said: "It has been shown that the orientation of breast cancer cell division is much more random than that of healthy cells. We want to find out if this could be a predictor to cause cancer or if it has no relation. Being a Turing Fellow I will be able to share my expertise in mathematical modelling, and I will have access to researchers who work with large high-dimensional datasets who can help me analyse the complex data involved in my research."

Predicting the ageing process

Turing Fellow and IfLS member Dr Nick Fuggle, from the MRC Lifecourse Epidemiology Unit, is looking at indicators that can predict those at risk of accelerated biological ageing with a focus on musculoskeletal health.

By using clinical parameters, epigenetic marks and specialist imaging, he is trying to identify who may be at risk of conditions such as osteoporosis, osteoarthritis and sarcopenia (muscle loss). This would allow early intervention and amelioration of the risk of these diseases of musculoskeletal ageing.

He said: "The Turing Fellowship has allowed me to build relationships and collaborations across The Alan Turing Institute. I have connected with colleagues who have diverse, interdisciplinary interests in machine learning, health services, epigenetics and image processing, which is resulting in a substantial broadening of my research horizons."

Tackling antibiotic resistance

Research by Professor Syma Khalid and her team in Chemistry will have a big impact on the current, global fight against antimicrobial resistance.

Syma will be using Southampton's high performance computer – Iridis 5 – as well as the national Supercomputer – ARCHER – to help design new antibotics.

The team is creating accurate computer models of molecular assemblies within biological systems to better understand how bacteria respond to antibiotics, in order to develop improved, more potent drugs.

She said: "Working with The Rosalind Franklin Institute will facilitate cross-disciplinary studies, so we can combine our computational work with data from colleagues who do wet-laboratory science to provide greater insights."

Lens-less imaging at the nanoscale

A collaboration between Chemistry and Southampton's Zepler Institute hopes to bring an innovative microscopy tool application that has the potential to look at biological systems at a much higher resolution and definition.

Professor Jeremy Frey, from Chemistry, and Dr Bill Brocklesby, from the Zepler Institute, are among the first researchers in the world to demonstrate lens-less imaging on actual biological samples using extreme ultraviolet light, which gives much higher resolution than optical microscopy.

Jeremy said: "Usually metal coatings or fluorescent dyes need to be added to samples before images are taken, but we have been developing a coherent light source over the past few years that enables us to take measurements from samples without having to do too much to the sample beforehand.

"This is opening up a whole new way of looking at the sub-cellular structure, revealing information that hasn't been seen at this level before. By taking this novel technology to The Rosalind Franklin Institute, we will have access to much larger equipment that will enable us to improve the resolution of our lens-less imaging to the nanoscale."

Bill added: "We are hoping that the images that we can now produce of nanoscale biological structures can make a case for investment in the next generation of these tools. We will be creating a pathway that could make this imaging equipment more compact allowing it to be rolled out for use more generally in biology."

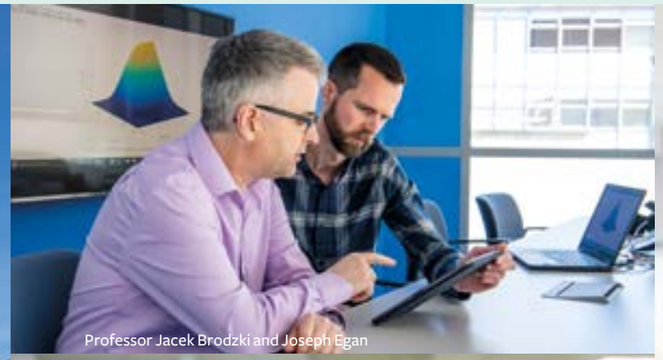
These advances will contribute to the general themes of correlative microscopy – a focus of development at The Rosalind Franklin Institute.

"It is a great pleasure to become a core part of these two major institutes. It reflects the strength we have in life sciences research across many disciplines."

Professor Peter JS Smith
Director of the Institute for Life Sciences

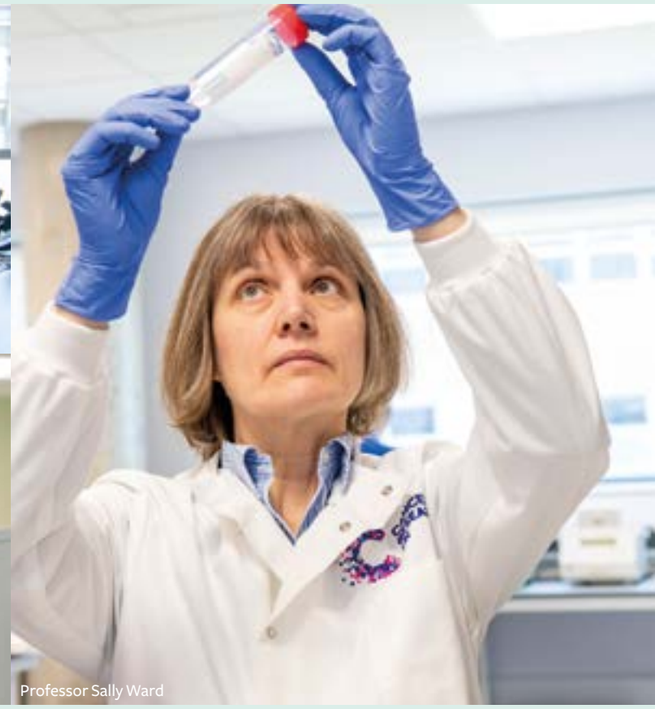
COLLABORATING AT THE FOREFRONT OF CANCER IMMUNOLOGY

The Centre for Cancer Immunology



Professor Jacek Brodzki and Joseph Egan

Professor Tim Elliott



Professor Sally Ward

For more than 40 years, scientists at the University of Southampton have been at the very forefront of cancer immunology research and have an international reputation for bench to bedside results.

The Centre for Cancer Immunology (CCI) – the UK's first dedicated centre for cancer immunology research - was developed by the University to bring together world-leading scientists to improve our understanding of how immunity to tumours can be stimulated and to expand clinical trials and develop more lifesaving drugs in this exciting and promising area of cancer research.

At the heart of the CCI is the ethos of interdisciplinarity and translational medicine – principles that are supported by the University's Institute for Life Sciences (IfLS) with which the CCI has a close affiliation.

CCI Director and Deputy Director of the IfLS Professor Tim Elliott said: "These two principles are pillars of the IfLS and I was keen to ensure that they are central to the research strategy of the CCI. Our research in cancer immunology relies on scientists from many different fields working closely together to solve key challenges and drive forward research in this area; and its application to treating cancer relies on integrated teams of doctors, scientists, nurses and clinical trials experts."

A close collaboration

Tim said: "The IfLS has created an environment where researchers understand the value of working across disciplines. This has helped us establish real interdisciplinary connections that are enabling us to channel our discoveries from our labs to patients for the very first time.

"The IfLS has helped to broker important interdisciplinary connections for us. Combining our immunology expertise with world-leading engineers, computer scientists, chemists and mathematicians, allows us to tackle big questions like how the human immune system reacts to cancer, in innovative ways."

Embedding in the CCI

IfLS member and Professor of Pure Mathematics Jacek Brodzki is the first research sabbatical fellow to spend a year embedded in the CCI, using his skills in topological modelling techniques to better inform and understand big data in scientific experiments.

Jacek said: "Cancer immunology research is based on cutting-edge experiments that create vast amounts of really complex and multidimensional data which is not easy to analyse using the standard methods. Topological data analysis provides new insights into the outcomes of experiments and suggests new ways to organise and interpret the data.

"My sabbatical offers me the crucial opportunity to speak directly to the experts to understand the underlying problems and motivations for the experiments. I am planning to develop new methodologies to support the work at the Centre, and set up a new research programme in applications of topology specifically to cancer immunology."

Studying at the boundaries of Maths and Medicine

IfLS student Joseph Egan is a mathematical modeller based at the CCI, who is using his mathematical skills to help the cancer immunologists better understand the interactions between cells of the immune system and tumour cells.

He was inspired by the interdisciplinary research at the CCI and decided to take up the PhD, which crosses the boundaries of Maths and Medicine.

He said: "I'm really interested in using my mathematical modelling skills in a real-world setting. I work with a team of leading immunologists, and the idea of being able to develop models based on their experiments, and for these models to then guide future experiments, is incredibly exciting."

Attracting leading international researchers

Southampton's interdisciplinary culture and international reputation for translational research were instrumental in attracting Professor Sally Ward and Professor Raimund Ober to the CCI.

Leaders in the field of antibody-related therapeutics, the pair relocated to the CCI to head up a joint interdisciplinary laboratory. This laboratory combines Sally's expertise in finding new ways to engineer antibodies to help them destroy cancer cells and understand how immune responses can be modulated for therapy, and Raimund's research in developing new super-resolution imaging techniques to study the fate of therapeutic anti-cancer antibodies as they attack cancer cells.

Their pre-clinical research has already helped them secure two key grants to support their research – £2.2m from Cancer Research UK and £2.7m from the Wellcome Trust.

Sally said: "We were impressed with the strong ethos of interdisciplinarity at Southampton. The CCI and the IfLS are great examples of how this can be embedded within organisations. We have already been liaising with members of the IfLS about potential ways of working together in the future."

Find out more:
www.southampton.ac.uk/youreit

"The Centre for Cancer Immunology is unique in its interdisciplinary and translational approach to cancer research involving researchers from many different disciplines ranging from mathematicians to clinical researchers. Collaborating with IfLS researchers provides exceptional opportunities for groundbreaking research."

Professor Raimund Ober
Professor of Imaging and Biomedical Engineering, Centre for Cancer Immunology, Southampton

REVOLUTIONISING BIOMEDICAL IMAGING

"This research is an excellent example of how funding of a small pilot project lays the foundation resulting several years later in major grant funding. This is a fantastic collaborative achievement."

Professor Peter JS Smith
Director of the IfLS

"Coupling expertise from Medicine and Engineering across the disciplinary boundaries has been fundamental to this project and has resulted in significant research funding and commercial engagement."

Professor John Holloway
Associate Dean (Research) in Medicine

"This project builds on our long-standing collaborative commitment to high-resolution X-ray imaging at Southampton. In the field of imaging conventionally mounted biomedical samples, the teams at Southampton are clearly world leaders."

Ian Haig
VP Engineering, X-ray Special Projects
Nikon X-Tek Systems Ltd

Image: First-of-a-kind soft tissue-optimised micro-computed tomography(µCT) scanner in Southampton for 3D X-ray histology. https://doi.org/10.1016/j.ajpath.2019.05.004

Over the last two decades, high-resolution 3D imaging of hard tissues such as bones and teeth by X-ray micro-computed tomography (µCT) has become a routine tool in biomedical and pre-clinical research.

Until recently it has been thought impossible to generate similar high-resolution µCT images from soft tissues that have not been specially prepared for increased X-ray contrast.

Pioneering research by an interdisciplinary team of Institute for Life Sciences (IfLS) members has revolutionised this area of biomedical imaging by developing a µCT scanner capable of producing non-invasive 3D scans of soft tissue biopsies at microscopic resolutions. It reveals features hundreds of times more detailed than conventional CT scans - comparable to 2D light microscopy images from conventional tissue sections.

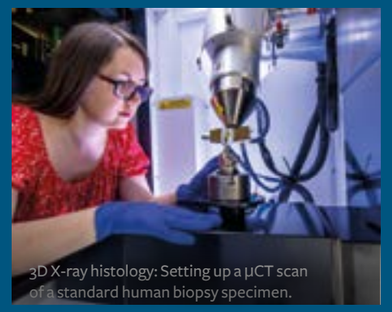
The first generation of this scanner has been operational in Southampton for the last three years and a variety of soft tissue samples including lung, colon and liver have been imaged and analysed. The work is attracting international interest from biomedical researchers and clinicians keen to try µCT in their work.

The research has further strengthened and established new relationships with industrial partners, including Nikon X-Tek Systems Ltd and DECTRIS Ltd. The team at Southampton has received nearly £2m of Wellcome Trust funding and support from industry to develop, standardise and drive uptake of their innovative µCT technology for 3D X-ray histology.

The history

Five years ago, the highly interdisciplinary team of researchers from Medicine and Engineering, together with the Biomedical Imaging Unit (BIU) and the µ-VIS X-ray Imaging Centre, received proof-of-concept funding from the IfLS.

Dr Philipp Schneider, Academic Director of the µ-VIS X-ray Imaging Centre, said: "That initial IfLS funding encouraged us to come closer together as a cohesive unit, to further develop our research, and generate microscopic 3D images of lung tissue from which we could gather proof-of-principle data to demonstrate what we were trying to achieve."


3D X-ray histology: Setting up a µCT scan of a standard human biopsy specimen.

Dr Peter Lackie, Academic Lead in the BIU, said: "The pilot data we created was crucial and ground-breaking. It was the first time that anyone had done this 3D scanning of soft tissue in standard wax blocks, and it allowed us to bid for further funding culminating in the large Wellcome Trust grants."

Potential impact

This high-resolution way of scanning soft tissues is the imaging of the future. It opens up a wealth of new information to biologists, biomedical scientists, medical researchers and clinicians, enabling them to see and quantitatively analyse the microstructures of soft tissue biopsies in their 3D context.

These lung tissue scans have already helped medical researchers to understand more about respiratory diseases. They have revealed important details of the processes involved in lung fibrosis and chronic obstructive pulmonary disease that will help inform future treatments.

Manager of the BIU Dr Anton Page said: "The research is a critical part of our internationally competitive 3D biomedical imaging capability at Southampton." Professor Ian Sinclair, Senior Advisor of the µ-VIS X-ray Imaging Centre, said: "We have already had interest from medical and biomedical researchers, and clinicians across Europe who would like to employ this technology."

Collaboration

The team's main collaborator during the project has been Nikon X-Tek Systems, who co-funded two PhD students, and developed the scanner that was used for the initial work funded by a Wellcome Trust Pathfinder grant.

In addition to the system at Southampton, other identical prototypes have been installed at GreatOrmond Street Hospital (GOSH) London and Memorial Sloan Kettering Cancer Centre in New York and are being used to develop other applications of µCT in medicine.

The team has also liaised with expert histopathologists around the world, receiving positive feedback about the 3D microstructures and the diagnostically relevant information their scans reveal.

The future

Their second Wellcome Trust grant aims to increase the scanner's throughput; standardise the image acquisition and processing workflows; raise awareness and drive uptake of 3D X-ray histology; and further benchmark state-of-the-art X-ray source and detector technology to be integrated in the future. They are looking forward to collaborating with University colleagues to fully exploit their novel data, using machine learning tools and artificial intelligence for diagnosis of diseases and patient stratification.

DECTRIS Ltd is the world leading Hybrid Photon Counting (HPC) detector manufacturer for scientific applications and will provide a HPC detector to generate zero electronic noise and fast imaging at high resolution and maximum sharpness.

Find out more:
www.xrayhistology.org

CATALYSING OUR EXPERTISE IN ECOLOGY AND EVOLUTION

Safeguarding the future of our planet is the biggest challenge facing society today.

With species under threat and habitats being destroyed, we are having to take a close look at how we can protect our ecosystems and sustain our living systems for the future.

At Southampton, we have significant research strengths in ecology and evolution that are having an impact on understanding the resilience of species from the smallest organism to the most complex ecosystem.

This expertise across the University is being drawn together by the Institute for Life Sciences (IfLS) to create a strong, cohesive network of research and education – the Evolution Group that is facilitating interdisciplinary work between diverse areas including Ocean and Earth Sciences (OES), Biological Sciences, Mathematics, Electronics and Computer Science and Engineering.

Southampton's expertise

Director of the IfLS Professor Peter JS Smith said: "Across the University there are tremendous skillsets in the areas of ecology and evolution and we are seizing the opportunity to bring this group together as one cohesive community.

"As part of Southampton's life sciences strategy, we want the University to be recognised as a hub of expertise in these areas. By drawing together all of these groups, they will be in a stronger, unified position to expand their research impact, enable more collaborative opportunities, and further increase their significant grant income."

Working together to target eco-evolutionary synergies, IfLS member Dr Thomas Ezard is co-ordinating the evolutionary aspects with Dr Jasmin Godbold co-ordinating on the ecology side.

Thomas said: "The University is demonstrating the impact of the excellent research that is being carried out in various areas of evolution. In the last three years, we have won more than £2.5m from the Natural Environment Research Council (NERC) and the Biotechnology and Biological Sciences Research Council (BBSRC). We are also a key part of an international multidisciplinary team taking part in a $8.5m project supported by the John Templeton Foundation which recognises the importance of integrated sciences across disciplines."

Studying the adaptive response of bats

IfLS member Dr Orly Razgour is a NERC Independent Research Fellow and Lecturer in Ecology who is exploring the evolutionary and ecological responses to global change to understand how we can better manage the environment and conserve biodiversity.

She primarily focuses on looking at the effect of environmental change on bats and the way they have responded to these changes.

She said: "Bats are good indicators because they are a widespread, diverse group of organisms that enable us to study the potential responses of both birds and mammals. My research is investigating how environmental change has affected bat species across Europe, Africa and the Middle East to help identify the traits that make them particularly vulnerable to future change.

"By understanding how they adapt and how the ability to adapt differs between populations, we can look at where we need to focus our conservation efforts."

Orly recognises the importance of interdisciplinary work in her research. She said: "These are big global issues that require analysis and data from different disciplines in order to fully understand the problems and what the responses to those problems are.

"I am working with other evolutionary biologists from across the University to try and develop mathematical models of evolution and adaptive responses. These different strengths from different faculties are vital to advance my research."

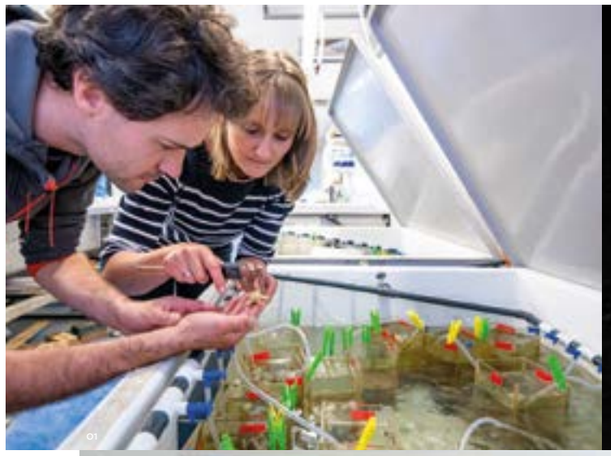
Crop domestication as a model for evolution

Associate Professor in Biology Dr Mark Chapman is using Brassica crops to deliver a new understanding of how evolution works.

As part of his NERC and BBSRC project with Dr Thomas Ezard, from OES, Mark is examining Brassicas, such as turnips and cabbages, to find out how populations diverge and become separate species. He is looking at how individual plants change to best match the prevailing environment – known as phenotypic plasticity.

He said: "We have seen that wild turnips grown in a cultivated-like environment start to resemble cultivated turnips, and their gene expression starts to alter too. So we are asking ourselves if wild species have been selected by humans because of this plasticity?

"By analysing several Brassica crops and their wild relatives, we can see if the same changes happen in different species, giving us a new understanding of evolution and how important the different types of plasticity are in driving evolutionary divergence among species."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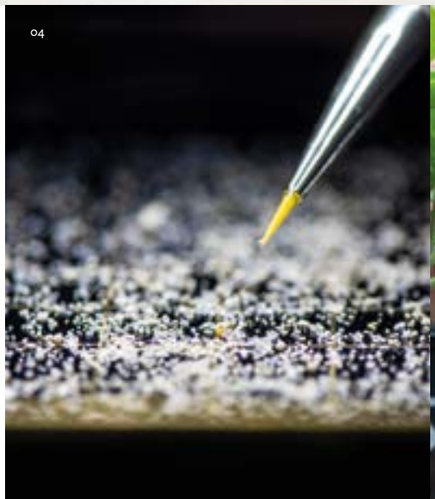
01 Dr Jasmin Godbold and Dr Adam Reed measuring the size of a mudstar at the University's Biodiversity Ecosystem Futures Facility.

02 Dr Orly Razgour sampling bats in Spain to study adaptations along climatic gradients.

03 Dr Mark Chapman and postdoctoral research fellow Jasmine Saban prepare DNA samples for genome sequencing.

04 Fossilised plankton being studied in Dr Thomas Ezard's lab

05 Examining the phenotypes of plants in different growth environments.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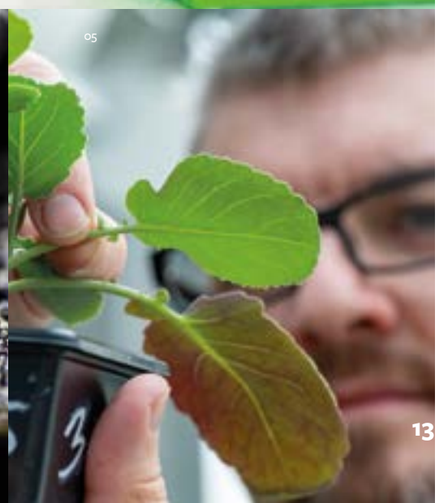
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TRANSFORMING PRECISION MEDICINE THROUGH DATA ANALYTICS

Image: Dr Paul Skipp

Southampton's unique in-depth expertise in multi-omic technologies, combined with access to patient cohorts from world-leading collaborative clinical partners, is helping to transform precision medicine across the disease spectrum from cancer immunology to respiratory conditions.

The newly-established Integrative Molecular Phenotyping Centre (IMPC) is bringing together 'omic experts from across the University to use multi-omic data, in combination with clinical data, to better understand disease and enable more personalised and effective healthcare treatment and diagnosis.

The new Centre, which is part of the Institute for Life Science (IfLS), will drive forward interdisciplinary research using molecular phenotyping to explore individual variability in genes, environment and lifestyle. This will allow doctors and researchers to predict more accurately which treatment and prevention strategies for a particular disease will work in which groups of people.

Southampton's unique position

Dr Paul Skipp, Associate Professor in Proteomics, is leading the development of the Centre that draws together expertise from Medicine, Biological Sciences, Mathematics and Engineering. He said: "Southampton is in a unique position because we have experts in numerous 'omic technologies and data science and have excellent collaboration with our clinical partners both in the UK and across Europe.

"It is only by working together that we can really understand the mechanisms behind diseases. Not only are we carrying out the innovative research here, but our established clinical links mean we can translate that research into the clinic and through to the patient.

"By using molecular signatures from multi-omics data - genomics, transcriptomics, proteomics, glycomics and metabolomics - in combination with clinical data, we can enable better tailoring of existing treatments, and pave the way for the development of new therapeutics and diagnostics for improved patient outcome.

"However, the data that we are generating from this research is huge. The IMPC will enable us to develop critical new approaches to integrate and analyse this data and extract the information we need from these big datasets.

"The combination of all the work we are doing at Southampton, particularly in the areas of cancer, respiratory and infectious disease, is changing the way we look at disease and places us as leaders in precision medicine."

Research impact

Southampton is already making an impact in molecular phenotyping and precision medicine:

TopoMD - is a group of scientists and mathematicians from the University whose exciting research is promising to revolutionise healthcare by allowing high resolution investigation of molecular mechanisms underlying disease, and therefore enabling development of targeted treatments for application in personalised medicine. They are using revolutionary topological algorithms to plot the shape of a patient's gene expression and compare it to the shape of gene expression characteristic of diseases for precise and accurate diagnosis.

Asthma – using clinical and 'omics data from hundreds of adults and children with severe asthma we are able to understand more about different types of asthma to ensure better diagnosis and treatment for each person and uncover new information and ideas that could lead to the creation of effective new treatments. The team has recently identified novel molecular sub-types of asthma that are used in clinical trials to better predict therapeutic efficacy.

Cancer - in collaboration with the Southampton Centre for Cancer Immunology, the team is using multi-omics approaches to identify human leukocyte antigen (HLA) class-I and class-II peptides presented to T-cells in a number of cancers which are crucial for designing innovative personalised therapeutics and vaccines against cancer and other diseases.

Breast cancer – using molecular phenotyping data collected from 3,000 patients over five years, we are discovering new biomarkers for assessing the risk of developing secondary breast cancer, breast cancer recurrence and how diet and lifestyle factors could influence the outcome of the disease.

Image: Team discussing infant feeding tubes in the Neonatal Unit, Princess Anne Hospital.

RESEARCHING BIOFILMS IN INFANT FEEDING TUBES

Institute for Life Sciences (IfLS) PhD student Chris Winnard's research into the development of biofilms in neonatal nasogastric tubes has been going from strength to strength.

Three years ago Chris won a national award - the prize for best research poster at the National Nurses Nutrition Group annual conference.

More recently, he has developed a representative feeding model to help simulate biofilm contamination on infant feeding devices within a laboratory setting; is talking about his work at The American Society for Microbiology's (ASM) Annual conference, in San Francisco, for which he has been awarded their ASM Student and Postdoctoral Travel Award; and is running a clinical trial at Southampton's Princess Anne Hospital neonatal unit, collecting used tubes to gain a deeper understanding on the true diversity of contaminants.

He said: "The data from the clinical trial is being analysed and is starting to uncover fascinating information about the true diversity of micro-organisms found, and how different specific care regimes are altering these populations.

"The representative feeding model aims to get a deeper understanding of contamination, but also provide a tool for health care professionals to model and understand how different feeding and care regimes could have impacts on contamination."

Chris' postgraduate thesis research, funded by the IfLS, Health Sciences and Biological Sciences, is nearing completion. He said: "The opportunity to undertake such a project is only possible due to the support and infrastructure provided to me as part of my studentship and is a real testimony to the quality of research that can be conducted at the University.

"The experience I have gained, combined with the opportunities afforded me, has allowed me to enjoy my research experience, and I am excited to continue my research career into the future." Chris is supervised by Dr Sandra Wilks, Professor Bill Keevil and Professor Mandy Fader.

The team is developing technologies to improve access to prosthetics.

ADDRESSING THE CHALLENGES IN DEVELOPING COUNTRIES

Interdisciplinary researchers in the Institute for Life Science (IfLS) have received three project grants from the Global Challenges Research Fund (GCRF) - a £1.5 billion fund announced by the UK Government to support cutting-edge research that addresses the challenges faced by developing countries.

The IfLS-related projects are:

- Academics from Engineering and Physical Sciences, Health Sciences and Medicine are working on a three-year project to improve access to artificial limbs in lower and middle income countries. Two studies are being carried out with clinician and education partners in Cambodia, aiming to develop digital tools to increase prosthetic and orthotic services, train prosthetist-orthotists and ensure funding is spent more efficiently.

- Infection researchers, engineers and bioinformaticians from Southampton and University College London have developed a new 3D system to study human infection in the laboratory. The spheres are allowing researchers to carry out a project in Durban, South Africa, to further investigate what happens in the human body when tuburculosis develops. Their long-term aim is to identify new antibiotic treatments and vaccines.

- Researchers in Southampton and Malaysia are carrying out a pioneering study that could lead to the development of a vaccine to prevent head and neck cancer. Teams based at the NIHR CRUK Southampton Experimental Cancer Medicine Centre and Cancer Research Malaysia, are studying precancerous lesions in the mouth which, if left untreated, can progress into head and neck cancer. They are focusing on testing the lesions for markers which can then be targeted by vaccination and is the first study aimed at creating a vaccine to prevent a form of cancer developing.

NEW RESEARCH CENTRE TO TACKLE DEMENTIA AND BRAIN AGEING

Institute for Life Sciences (IfLS) member Professor Roxana Carare, together with Dr Christopher Kipps at the University Hospital Southampton NHS Foundation Trust, are leading the creation of a new interdisciplinary research centre to address national challenges in the fields of dementia and brain ageing.

The understanding of dementia and neurodegenerative disease, together with improved therapies and delivery of care for people with these conditions, is a pressing need in the UK, and the South Coast region is recognised as an area where these problems are particularly acute.

The Interdisciplinary Dementia and Ageing Centre (IDeAC) is bringing together local expertise from across the research spectrum to form a dedicated interdisciplinary dementia and ageing research centre to address the problems in this complex field.

The IDeAC network, which is working closely with the IfLS, includes basic scientists, clinicians, health and social care delivery researchers, epidemiologists, imagers, mathematicians, and computing and data scientists.

Roxana is internationally renowned for her research into the causes of dementia and finding new therapeutic targets to help the many people affected by the disease. She said: "There is considerable local expertise in ageing and dementia and our aim is to bring this together into a network. IDeAC will seek to energise, co-ordinate and focus efforts to put us in a strong position to attract and sustain funding for a nationally recognised centre."

Christopher is a behavioural neurologist with expertise in dementia diagnosis, clinical trials and dementia service delivery. He said:"One third of us will be directly affected by dementia at some point in our lives. We need to advance our knowledge at every point along the dementia pathway from basic science to the organisation of clinical services to support patients and their carers. This is an excellent opportunity to make this happen in Southampton."

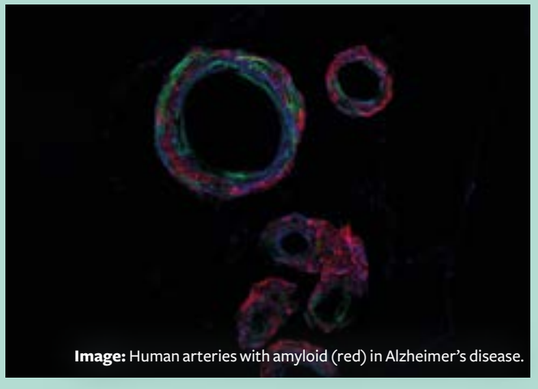

Image: Human arteries with amyloid (red) in Alzheimer's disease.

The Life Sciences Building

A sample of publications from our interdisciplinary postgraduate students: 2018-2019

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

Ashton JJ, Borca F, **Mossotto E,** Coelho T, Batra A, Afzal NA, Phan HTT, Stanton M, Ennis S & Beattie RM (2019). Increased prevalence of anti-TNF therapy in paediatric inflammatory bowel disease is associated with a decline in surgical resections during childhood. *Alimentary Pharmacology Therapeutics* 49(4), 398–407. DOI: 10.1111/apt.15094

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Scarpa E, Janeczek AA, Hailes A, de Andrés MC, De Grazia A, Oreffo ROC, Newman TA & Evans ND (2018). Polymersome nanoparticles for delivery of Wnt-activating small molecules. *Nanomedicine* 14(4), 1267-1277. DOI: 10.1016/j.nano.2018.02.014

Sri S, Pegasiou CM, Cave CA, Hough K, Wood N, Gomez-Nicola D, Deinhardt K, Bannerman D, Perry VH & Vargas-Caballero M (2019). Emergence of synaptic and cognitive impairment in a mature-onset APP mouse model of Alzheimer's disease. *Acta Neuropathologica Communications* 7, 25. DOI: 10.1186/s40478-019-0670-1

Sutton EJ, Bradshaw RT, Orr CM, Frendéus B, Larsson G, Teige I, Cragg MS, Tews I & Essex JW (2018). Evaluating anti-CD32b F(ab) conformation using molecular dynamics and small-angle X-Ray scattering. *Biophysical Journal* 115(2), 289-299. DOI: 10.1016/j.bpj.2018.03.040

Life Technologies

Anderson WJ, Nowinska K, Hutter T, Mahajan S & Fischlechner M (2018). Tuning plasmons layer-by-layer for quantitative colloidal sensing with surface-enhanced Raman spectroscopy. *Nanoscale* 10, 7138-7146. DOI: 10.1039/C7NR06656B

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Moura CC, Bourdakos KN, Tare R, Oreffo ROC & Mahajan S (2019). Live-imaging of bioengineered cartilage tissue using multimodal non-linear molecular imaging. *Scientific Reports* 9, 5561. DOI: 10.1038/s41598-019-41466-w

Moura CC, Lanham SA, Monfort T, Bourdakos KN, Tare R, Oreffo ROC & Mahajan S (2018). Quantitative temporal interrogation in 3D of bioengineered human cartilage using multimodal label-free imaging. *Integrative Biology* 10, 635-645. DOI: 10.1039/C8IB00050F

Núñez JA, Goring A, Javaheri B, Razi H, Gomez-Nicola D, Hesse E, Pitsillides AA, Thurner PJ, Schneider P & Clarkin CE (2018). Regional diversity in the murine cortical vascular network is revealed by synchrotron X-ray tomography and is amplified with age. *European Cells and Materials* 35, 281-299. DOI: 10.22203/eCM.v035a20

Yang X, Lennard KR, He C, Walker MC, Ball AT, **Doigneaux C,** Tavassoli A, & van der Donk WA (2018). A lanthipeptide library used to identify a protein–protein interaction inhibitor. *Nature Chemical Biology* 14, 375–380. DOI: 10.1038/s41589-018-0008-5

Living Systems

Ratto F, Simmons BI, Spake R, Zamora-Gutierrez V, MacDonald MA, Merriman JC, Tremlett CJ, Poppy GM, Peh KS-H & Dicks LV (2018). Global importance of vertebrate pollinators for plant reproductive success: a meta-analysis. *Frontiers in Ecology and the Environment* 16(2), 82-90. DOI: 10.1002/fee.1763

Insights through Data

Ashton JJ, Bonduelle Q, **Mossotto E,** Coelho T, Batra A, Afzal NA, Vadgama B, Ennis S & Beattie RM (2018). Endoscopic and histological assessment of paediatric inflammatory bowel disease over a 3-year follow-up period. *Journal of Paediatric Gastroenterology and Nutrition* 66(3), 402-409. DOI: 10.1097/MPG.0000000000001729

Ashton JJ, Borca F, **Mossotto E,** Phan HTT, Ennis S & Beattie RM (2018). Analysis and hierarchical clustering of blood results prior to diagnosis in paediatric inflammatory bowel disease. *Inflammatory Bowel Diseases* izy369. DOI: 10.1093/ibd/izy369

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Lee KM, Biedermann S & Mitra R (2018). Optimal design for experiments with possibly incomplete observations. *Statistica Sinica* 28, 1611-1632. DOI: 10.5705/ss.202015.0225

Lee KM, Biedermann S & Mitra R (2018). Optimal design when outcome values are not missing at random. *Statistica Sinica* 28, 1821-1838. DOI: 10.5705/ss.202016.0526

Lee KM, Biedermann S & Mitra R (2019). *D*-optimal designs for multiarm trials with dropouts. *Statistics in Medicine* 38(15), 2749-2766. DOI:10.1002/sim.8148

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Wang T, Mentzakis E, Brede M & Ianni A (2019). Estimating determinants of attrition in eating disorder communities on Twitter: an instrumental variables approach. *Journal of Medical Internet Research* 21(5), e10942. DOI: 10.2196/10942

"Global challenges will only be met when researchers work together in cross-disciplinary partnerships. Our future-looking IfLS studentship scheme fosters such collaborations to develop the next generation of research leaders. We are immensely proud of our outstanding students and fully expect them to be the movers and shakers of their chosen careers."

Professor Mandy Fader
Pro Vice-Chancellor (Internal Partnerships)

"Southampton's mental health research activity brings together doctors, psychologists, neuroscientists and health scientists to deliver translational research that will positively impact on people's lives.

Our expertise in child development, psychological interventions and affective neuroscience combine to deliver cutting edge research that has the potential to improve mental health treatments and wellbeing across the lifespan."

Professor Matthew Garner
Institute for Life Sciences and SoNG member and Head of Psychology
University of Southampton

Image: Changing Minds through Neuroscience Inspired Fashion is a collaboration between Peter Symonds College, the University's Winchester School of Art and the Southampton Neuroscience Group (SoNG) which aims to raise awareness of mental health. Dress designed by Stephanie Orlowski. It is shaped like a butterfly with repeated prints of brain scans from a stroke patient and is worn with a "cocoon" cape.

Find out more:
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