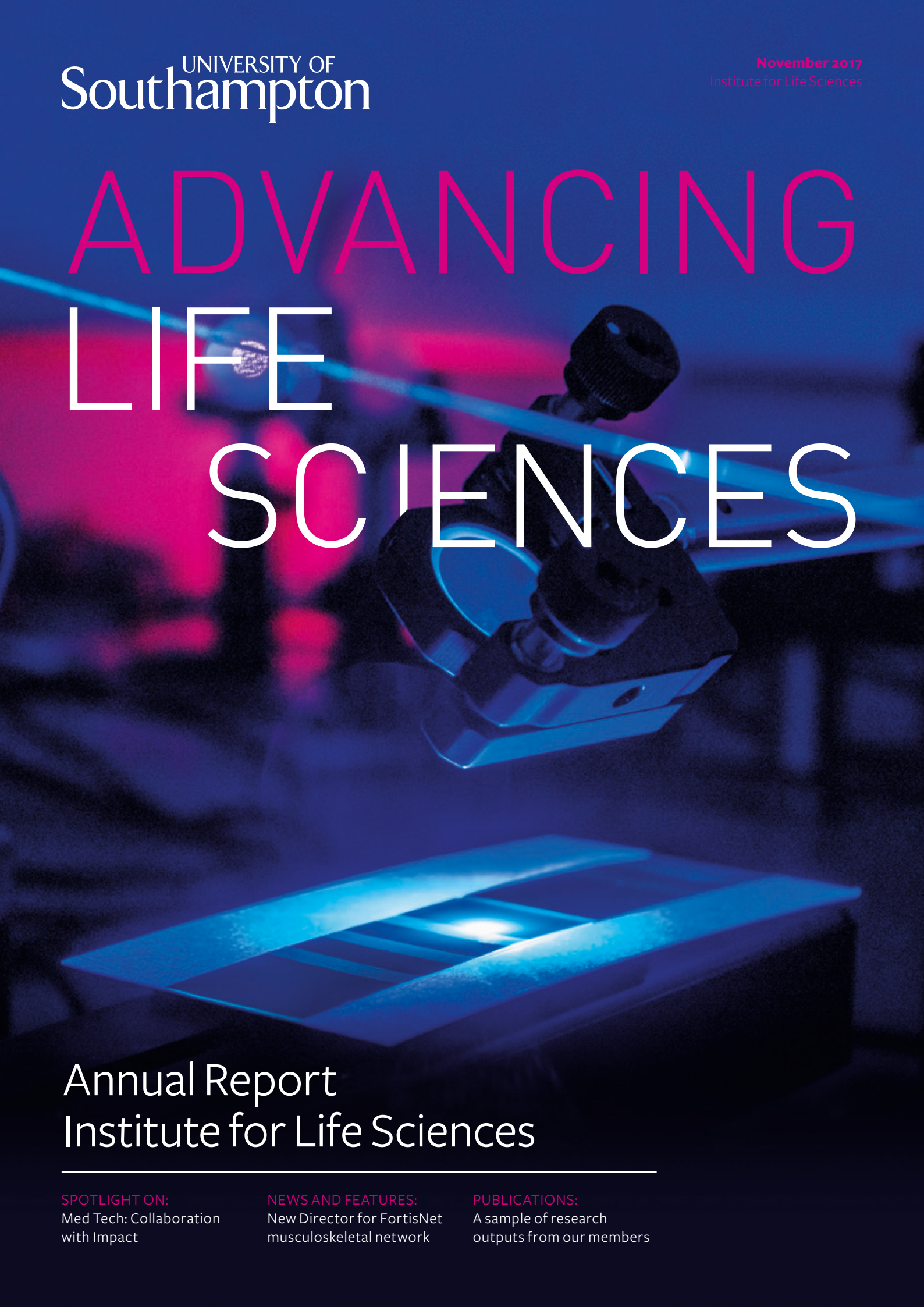
UNIVERSITY OF Southampton

November 2017
Institute for Life Sciences

ADVANCING LIFE SCIENCES



Annual Report
Institute for Life Sciences

SPOTLIGHT ON:
Med Tech: Collaboration with Impact

NEWS AND FEATURES:
New Director for FortisNet musculoskeletal network

PUBLICATIONS:
A sample of research outputs from our members

IN THIS REPORT

This year's Institute for Life Sciences' report highlights key research areas and exciting developments including the Institute's increasing national and international impact.

The recent publication of the UK Life Sciences Industrial Strategy shines the spotlight on the importance of this sector to the UK's economy and international standing, and the University of Southampton is playing an integral part in improving health, life sciences research, innovation and employment.

Professor Sir Christopher Snowden
President and Vice-Chancellor
University of Southampton

Since last year's report the Life Sciences community at the University of Southampton has continued to experience success in innovation and research in the global Life Sciences agenda.

We have contributed to shaping the region's industrial outlook, through participation with Local Enterprise Partnerships and accepted the invitation to become a partner of the new Rosalind Franklin Institute - which focuses on disruptive life science technologies at the physical sciences and engineering interface.

Locally we continue to develop our ties with other research-based organisations such as the Defence Science and Technology Laboratory as well as participating in the research plan for the University Hospital Southampton NHS Foundation Trust.

Catalysing interdisciplinary research remains the hallmark of the Institute's activities and an important part of the University's strategic aims. Across the University our grant portfolio in the life sciences continues to grow, a success story recognised by the initiative to develop a life sciences strategy fit to fully exploit our achievements in the life sciences and propel us forward over the next 10 years.

The future will be challenging but Life Sciences at Southampton is well placed to drive novelty in research, innovation and teaching.

Professor Peter J S Smith
Director, Institute for Life Sciences

Cover Image: Laser-patterning of a porous paper substrate with a low-power blue laser creating a microfluidic device with a user-defined geometry. (see pages 8-9)

To find out more, visit:
www.southampton.ac.uk/ifls

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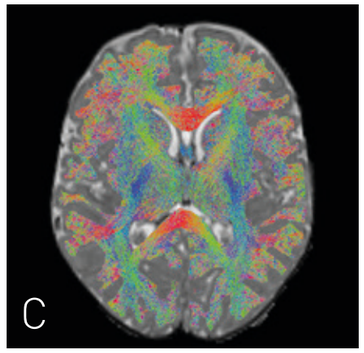
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A - Professor Sir Christopher Snowden, President and Vice-Chancellor, University of Southampton, with Kathy Slack, Director of Enterprise M3 LEP, and Sue Littlemore, Higher Education Partnership Manager of Enterprise M3 LEP.
B - Laser-patterned microfluidic paper-based device tested for fluid-flow with coloured ink solutions.
C - A whole-brain tractogram of one study participant consisting of 3x10^5 streamlines overlaid on a 3D-T2w image.
Image courtesy of: Finn Lennartsson, Clinical Neurosciences, Clinical and Experimental Sciences, Faculty of Medicine.

MED TECH: COLLABORATION WITH IMPACT

Advancements in Medical Technologies:
Nano litre droplets containing samples collected from tissue fluid. These droplets can be analysed in real-time in a wearable 'bioanalyser' to give continuous readout of metabolic or other biochemical changes in the body.

To find out more, visit:
www.southampton.ac.uk/ifls/enterprise

Medical Technologies (Med Tech) is a growing multibillion pound enterprise in the UK that is revolutionising healthcare through the prevention, diagnosis and treatment of a range of diseases and medical conditions.

Underpinning these advances are data or 'Digital Enabling Technologies' – our ability to analyse, gain new insights, make predictions, communicate and store complex information rapidly and securely – which are critical to success in the Med Tech sector.

Southampton's Institute for Life Sciences (IfLS) is at the forefront of plans to draw together expertise across the south and position the region as an outstanding environment for Med Tech and Digital innovation and growth.

The Med Tech economy

Med Tech is a diverse sector encompassing a range of medical devices and processes from imaging equipment to hearing aids, and from prosthetics to pacemakers. It is high on the government's agenda and forms a potential part of its developing Industrial Strategy.*

Kit Malthouse MP, Chair of the All-Party Parliamentary Group for Life Sciences, has described the life sciences sector as a "jewel in the crown", while industry bodies value life sciences' direct contribution to the UK economy as £14.5b in 2015, greater even than other key UK sectors such as aerospace, oil or gas.

Med Tech companies employ 93,600 people across the UK, with about a quarter of Med Tech jobs located in the south east.

The sector is enjoying rapid growth, particularly in digital health, mobility access and drug delivery technology.

Expertise in the southern region

A recent review of life sciences expertise in the south revealed more than 300 companies or organisations active in this area, and noted particular strengths around medical technologies and data. The review, which was conducted by a collaboration of the IfLS, the Enterprise M3 Local Enterprise Partnership (LEP) and independent consultants OBN, found that there were more than 80 Med Tech companies in the Enterprise M3 region, which encompasses most of North Hampshire, the New Forest and West Surrey.

The findings have fed into a wider, government-sponsored audit of Science and Innovation across the south of England, carried out by a consortium of more than 120 public and private organisations, called Innovation South.

The audit identified the region's excellence in digital enabling technologies which support innovation and growth in a number of vibrant, high tech sectors including Med Tech. These distinguish the south from other parts of the UK.**

Professor Peter J S Smith, Director of the IfLS, said: "We believe that given the appropriate support and promotion, Med Tech South has strong potential to be one of the outstanding sectors for innovation and growth, both across the Innovation South region and nationally."

Kathy Slack OBE, Director of the Enterprise M3 LEP, said: "Having identified the Enterprise M3 region as home to a significant cluster of Med Tech firms, we are committed to ensuring that this marks the beginning of an ongoing collaboration that will secure the south as a region where life science businesses enjoy great success.

"Our regional assets in digital communications, especially 5G, cyber security, data analytics, photonics, and quantum devices and systems, deployed in the Med Tech sector will be critical for innovation, economic growth and global competitiveness for Enterprise M3, Innovation South and the UK."

Professor Peter J S Smith
Director, Institute for Life Sciences

* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/650447/LifeSciencesIndustrialStrategy_acc2.pdf

** https://www.gov.uk/government/publications/science-and-innovation-audits-second-reports-published

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

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Kathy Slack OBE
Director of the
Enterprise M3 LEP

The University as a key player
The Institute for Life Sciences at the University of Southampton, is playing a significant role in the development of Med Tech South.

Life sciences is a key part of the University's strategic plan. The IfLS was established six years ago to facilitate an inclusive environment supporting interdisciplinary research interests to broaden scientific opportunities and challenges in health, society and enterprise.

Peter said: "Life sciences is a strong, critical element of the University's focus and economy. This is a very exciting opportunity for the University to be involved in, distinguishing the region as an area for excellence in Med Tech."

FortisNet – a model of excellence
Med Tech South will build on the IfLS' previous experience of developing FortisNet - a pioneering, collaborative, interdisciplinary network of experts specialising in musculoskeletal health, including regeneration of broken bone and cartilage, joint replacement, prosthetic limbs, rehabilitation science and assistive technologies.

Peter said: "FortisNet brought together leading academics and businesses to put the emphasis on the end-users and drive research and enterprise opportunities into usable, impactful, effective products and applications.

"The development of Med Tech South will ensure that we continue to extend the impact of the University's Life Sciences expertise into the wider community."

A future region of Med Tech excellence
The IfLS and Enterprise M3 LEP now plan to act as a catalyst between Higher Education Institutions (HEIs), enterprise, patient groups and end-users to build effective pipelines of activity into the NHS and its clinicians.

They will be considering how Med Tech South could strengthen the region's economic identity, its reputation nationally and internationally, and catalyse quality job and wealth creation.

They aim to foster a community of life science practitioners and investors to drive excellence and economic growth in the south and beyond.

Professor Sir Christopher Snowden, President and Vice-Chancellor, University of Southampton, with Kathy Slack, Director of Enterprise M3 LEP, and Sue Littlemore, Higher Education Partnership Manager of Enterprise M3 LEP.

ENTERPRISE
M3 REGION

195
Life Science companies

84
Med Tech companies

28
Therapeutics Discovery and Development companies

IMPROVING HEALTHCARE THROUGH IMAGING

Southampton researchers are collaborating with scientists from the Defence Science and Technology Laboratory (Dstl) to develop innovative imaging technology that could have a significant impact on the future of healthcare.

IfLS member Dr Nicholas Evans and a Southampton team have been working with Dstl colleagues on two areas of healthcare – speeding up the repair of bones by using imaging to improve the understanding of particle uptake by cells; and reducing the use of antibiotics by exploring the ability of antibiotics to target bacteria within cells.

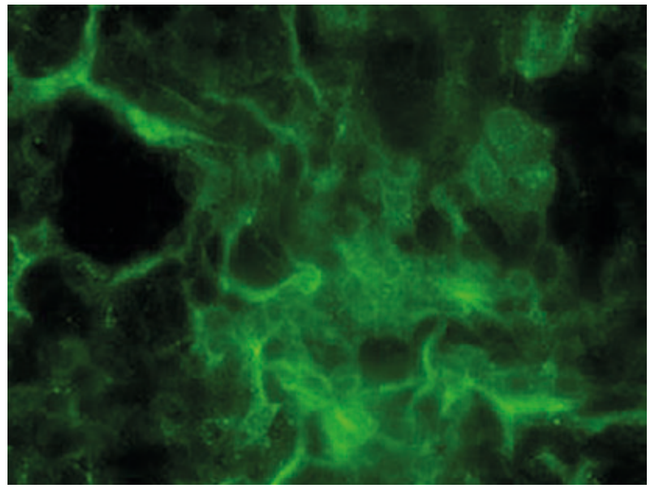
Nicholas said: "Reducing the use of antibiotics is a key challenge being addressed by today's society. Our research could see lower doses of antibiotics specifically targeted at the areas where they can be most effective.

"We are also looking at the delivery of new materials and drugs that can enable the bone structure to repair more quickly and effectively in the small minority of people where the bones don't heal properly. Initially we are investigating these potential applications for use within military healthcare, but they could have a much wider impact on general healthcare as well."

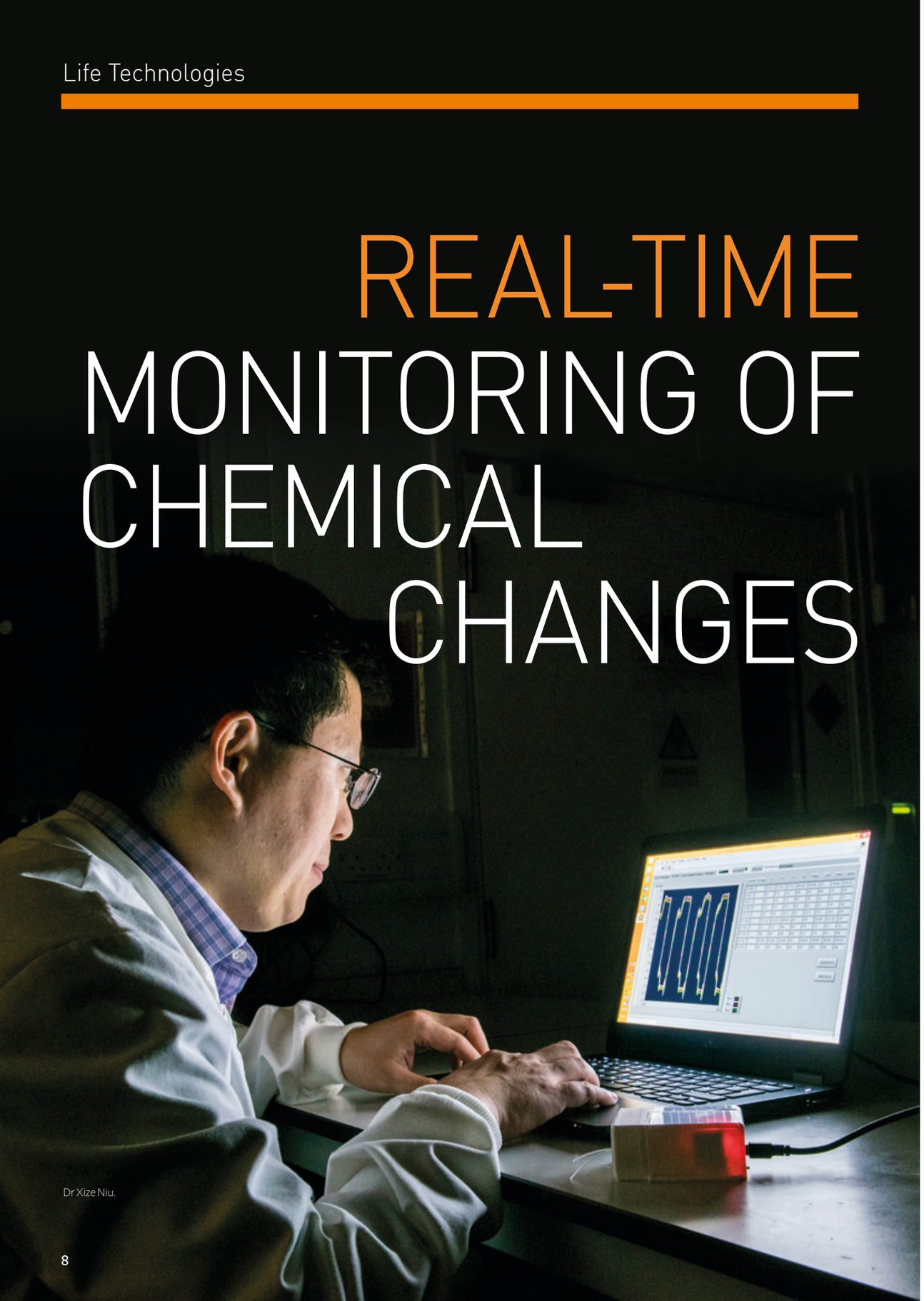
The University of Southampton and Dstl collaboration has received a variety of funding - including IfLS FortisNet pump priming, an Engineering and Physical Sciences Research Council (EPSRC) Impact Acceleration grant, a Ministry of Defence award, and the Higher Education Innovation Fund.

Med Tech South aims to facilitate similar collaborations between academia and industry that will catalyse the translation of research into applications.

Fluorescent micrograph of bone stem cells.
Image credit: Dr Nicholas Evans



REAL-TIME MONITORING OF CHEMICAL CHANGES



Dr Xize Niu.

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

Our world is being transformed as sensors become smaller, more powerful and more adaptable. A global network of these portable devices is tackling key societal challenges by measuring everything from our heartbeat, to climate change.

Researchers at the Institute for Life Sciences (IfLS) are carrying out innovative work where sensor technology is used to help the future of healthcare and the environment.

Achieving continuous chemical monitoring

Society's approach to wearable sensors has changed with the ability to continuously monitor aspects of our health and fitness 24 hours a day.

However, it is still extremely difficult to successfully monitor the continuous chemical changes in our body or gauge the effectiveness of medical drugs.

Research by an interdisciplinary team from the IfLS could provide the solution to the problem with a device that allows real-time monitoring of chemical changes in healthcare and the environment.

IfLS Member Dr Xize Niu is leading the project developing a novel portable and wearable sensor – Fluicorder - that could transform the healthcare of patients with both critical and chronic conditions.

Xize, an Associate Professor in Engineering and the Environment, said: "Our technology will make it possible to continuously measure chemical and biological molecules in liquids with a high level of accuracy, leading to applications including wearable devices that monitor glucose and drug levels of the body, as well as non-medical uses such as remote pollutant sensors for our drinking water, rivers and oceans."

The devices have already been successfully trialled in hospitals to monitor diabetes and future cancer treatment drugs, and in rivers to take detailed water analysis to help understand better the fluctuating ecosystem.

Xize is working with colleagues in Electronics and Computer Science, Medicine and Health Sciences and has grant awards from the Engineering and Physical Sciences Research Council (EPSRC) and Natural Environment Research Council (NERC).

He said: "We are really excited about this technology and think it has massive potential to impact on multiple markets.

We have already created a spin-out company – SouthWestSensor Ltd – to take our product from prototype to the market."

Laser-patterning of a porous paper substrate with a low-power blue laser creating a microfluidic device with a user-defined geometry.

Creating paper-based diagnostic sensors

Low cost paper-based diagnostic sensors that could help in the global battle against cancer and tuberculosis, are being developed thanks to funding sources that include the IfLS.

An IfLS and Health Sciences Knowledge Transfer Fellowship enabled Principal Research Fellow Dr Collin Sones, from the Optoelectronics Research Centre (ORC), to work with colleague Professor Rob Eason, and academics in Medicine and Health Sciences, to explore the potential of creating microfluidic-based, laser-printed sensors that would allow rapid and affordable point-of-care healthcare.

The paper sensors are robust, user-friendly and disposable and would be easy to take out into the community or low and middle income countries to carry out on-the-spot diagnostic testing.

Collin said: "Laser-printed, paper-based sensors could have a significant impact on saving human lives by making possible rapid, remote and real-time diagnosis of many targeted diseases at an early stage. This could be carried out at a patient's bedside or out in the field, without the need for specialised equipment or trained medical personnel.

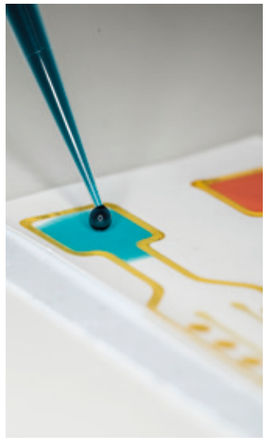
"The Knowledge Transfer Fellowship enabled me to produce grass roots data to access further EPSRC funding for future research. It also allowed me to bridge disciplines spanning the physical sciences and biosciences divide."

Rob said: "This funding was vital in allowing continuity of research and enabled us to explore a whole new area, which is a key ingredient of successful interdisciplinary initiatives.

The team's research has already led to two further EPSRC grants, three patents, and many journal publications and conference presentations, and they are looking at the potential of developing a spin-out company in the area of point-of-care diagnosis.

"The Knowledge Transfer Fellowship enabled me to produce data to access further EPSRC funding for future research. It also allowed me to bridge disciplines spanning the physical sciences and biosciences divide."

Dr Collin Sones
Principal Research Fellow,
Optoelectronics
Research Centre



Laser-patterned microfluidic paper-based device tested for fluid-flow with coloured ink solutions.

EMPOWERING RESEARCHERS TO IMPROVE HEALTHCARE

Dr Brigitte Vollmer and Specialised Clinical Physiologist Ben Ives review neonatal EEG data

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

Crucial seed funding from the Institute for Life Sciences (IfLS) is enabling researchers to compile data and the proof of concept they need to take their research to the next level to improve healthcare and enhance quality of health.

Assessing the impact of neonatal brain injury

Innovative imaging by Southampton researchers is helping to assess the acute and chronic effects of the reduction of oxygen on the brain of newborns.

Higher Education Innovation Fund (HEIF) money allocated by the IfLS is supporting research into the application of novel magnetic resonance imaging (MRI) methods and quantitative electroencephalogram (EEG) to identify biomarkers of brain injury in the first days after birth. These biomarkers help predict long-term health outcomes for the child.

The reduction of oxygen to the brain immediately before or after birth is a significant problem with between three and five newborns per 1,000 live births affected in developed countries, and 1.3 to 1.7 per 1,000 live births in the UK suffering hypoxic ischaemic encephalopathy (HIE).

Newborns with HIE are at high risk of brain injury with subsequent developmental problems including severe neuromotor, cognitive and behavioural impairment. Data from the clinical assessment of two-year-olds with neonatal HIE treated in Southampton indicates a high incidence of cognitive impairment, attention problems and increased risk of autism spectrum disorder symptoms. Early identification may allow future, novel treatment opportunities.

These life-long conditions can have significant implications for the affected children and their families, and the cumulative costs for their long-term care provision has become a serious economic burden.

Early diagnosis and prediction of outcome is important and this project aims to scan infants within five days after birth.

Principal Investigator Dr Brigitte Vollmer, from Medicine, said: "Our research is providing important novel information on how the development of anatomical and functional brain networks are affected by neonatal HIE. By significantly enhancing our understanding of the effects of HIE on the neonatal brain, we aim to improve the early prediction of neurodevelopmental outcomes in affected newborns."

Brigitte is working with Co-Principal Investigator Professor Koushik Maharatna, from Electronics and Computer Science, as well as colleagues from Medical Physics and Clinical Neurophysiology at University Hospital Southampton NHS Foundation Trust, King's College London and the Karolinska Institute, Stockholm.

Exploring complex data to relieve skin conditions

More than 40 per cent of the UK's population suffers from inflammatory skin disease at some point in their life – a condition that can seriously affect their health and quality of life.

Research, supported by the Institute for Life Sciences (IfLS), is investigating therapeutic interventions aimed at improving the body's immune defences.

IfLS researchers are exploring how immune system and human skin can help prevent or cure inflammatory disorders, such as allergy, and has already generated significant interest from industry giant Unilever.

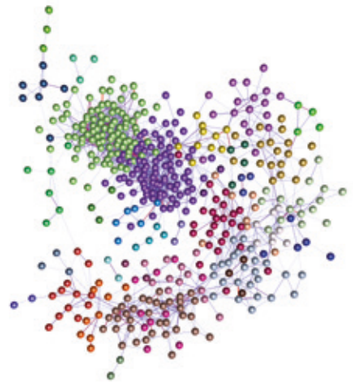
Dr Marta Polak, from Medicine, and Professor Mahesan Niranjan , from Electronics and Computer Science (ECS), used Higher Education Innovation Fund (HEIF) money to explore how skin can be used as a gateway to improving the body's immune defences.

Modern technology produces a wealth of complex datasets that are of extremely high biological value but extracting information from these datasets can prove difficult and restricted.

Marta and Niranjan have used bioinformatics and machine learning approaches – computational modelling analysing the data generated by advanced sequencing techniques - to produce their research results.

Marta said: "We and others have shown that skin not only provides effective immune defence, but can also efficiently help to shape body immune responses to allergens. Allergy is a chronic disease that is expected to affect more than 50% of all Europeans in 10 years' time. By better understanding how the immune responses are regulated in human skin we can create a strategy for allergy treatment and prevention."

The IfLS-allocated funding allowed the team to provide a proof of concept to bid for further money to investigate the immune regulation in scalp disease and work with Unilever to explore the effects of their cosmetic hair products.



The core network of genes co-regulated in human Langerhans cells, responsible for taking up pathogens and initiation of adaptive immune responses. Clusters of co-expressed genes are coded by colour.
Image credit: Published in Scientific Reports, 2017, 7: 668

"The support of the University and the IfLS in promoting collaborative research has allowed me to pursue my research interest in systems biology and has resulted in me securing a Wellcome Trust Sir Henry Dale Fellowship and establishing collaborations with Systems Immunology Centres around the world."

Dr Marta Polak
Wellcome Trust Research Fellow and IfLS member

Dr Marta Polak in the lab with Clinical Research Fellow Dr William Haw.

CHALLENGING EVOLUTIONARY CONVENTIONS THROUGH RESEARCH AND EDUCATION

Understanding the diversity of birds, at the time of dinosaurs, by looking at the development of living species *Anas platyrhyncos* - the duck. Seeing how skeletons change through development within a species will allow us to recognise juvenile and adult characteristics in the fossil remains of Mesozoic birds and so constrain diversity at this crucial time in avian evolution.

Evolution is at the centre of species survival from the smallest organism to the most complex ecosystems.

Without an ability to adapt to the changing environment, plants and animals would be wiped out and the Earth as we know it would be changed forever.

Environmental adaptation comes in many forms and can take place over a lifetime, over many generations, or over deep evolutionary time. A species' ability to adapt can have a potentially crucial impact on a wide range of areas from healthcare to agriculture.

Southampton's Institute for Life Sciences (IfLS) supports the University's key role in emerging research topics in this area.

At Southampton there are already considerable strengths and expertise in various areas of evolution research – evolutionary medicine, evolutionary ecology, evolutionary developmental biology, computational and mathematical models, and theoretical expansions. Improving interdisciplinary working across conventional subject boundaries – Extended Evolutionary Biology - creates a stronger position to help researchers tackle the challenges arising from areas that are still poorly understood.

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

A centre for evolutionary expertise
IfLS member Dr Richard Watson, from Electronics and Computer Science (ECS), is drawing together expertise in Extended Evolutionary Biology from across the University to provide a cohesive, strong network of research and education.

He said: "Evolution is a topic that addresses fundamental scientific questions about how living systems, from microbes to humans to ecosystems, change over time, and how they are resilient and able to cope with stresses. These fundamental questions have many high impact applications such as developing treatments for infections, cancer and obesity; as well as protecting biodiversity, and securing crop production from climate change and pest attack.

"There are exciting developments in current evolutionary biology that challenge conventional assumptions. These include the role of epigenetic inheritance, the role of phenotype plasticity in short-term adaptation and its potential to lead genetic evolution, and how natural selection changes its own ability to evolve over time.

"Understanding these complexities requires work that cuts across conventional disciplinary boundaries to develop new theoretical frameworks. Southampton's expertise is ripe to achieve this."

Southampton's strengths
The University of Southampton is already renowned for its research into various areas of evolution.

Dr Thomas Ezard, NERC Advanced Fellow, Associate Professor in Evolutionary Ecology in Ocean and Earth Science (OES), and IfLS member, is leading interdisciplinary research providing the first evidence about whether a lifetime of flexibility, or a stubborn refusal to change, influences the emergence of new species.

He is beginning a five-year NERC-funded research programme with colleagues in OES, ECS, and Engineering, alongside collaborators from the universities of Bristol, Leeds and University College London.

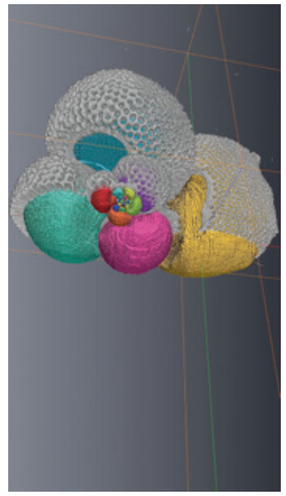
The team is exploring the fossil record of single celled organisms called planktonic foraminifera at unprecedented resolution using imaging technology within the µ-VIS X-Ray Imaging Centre, writing new computer programmes and exploiting novel geochemical techniques to reconstruct how the environment experienced by each single plankton individual changed from day-to-day millions of years ago.

Their goal is to investigate for the first time if certain parts of an individual's journey through life are more influential than others in determining the eventual evolutionary destinations of its species.

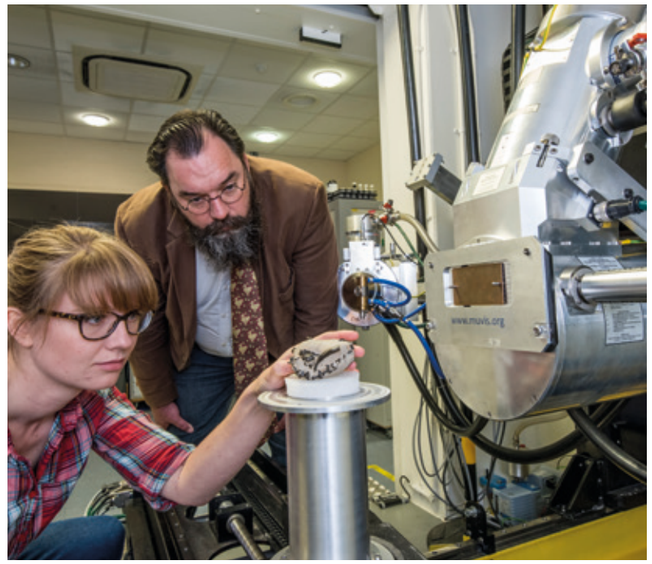
Thomas said: "State-of-the-art imaging technology has sparked a digital revolution in how biologists study life on Earth. By bringing together lessons from diverse scientific disciplines, we aim to answer one of the most fundamental of all biological questions - how do differences among individuals make differences among species?"

The future
As an organisation where education is informed by research, the University of Southampton is also developing a new MRes in *Evolution: from the Galapagos Islands to the 21st Century* that will bring together optional modules from Biological Sciences, ECS, OES, Geography and Medicine, and will include a field trip to the Galapagos Islands.

Richard said: "We want to let the outside world know about the pioneering research that is being carried out at Southampton. We will be working to gain more synergy from the work and expertise that already exists at Southampton, with the ultimate aim of leading to exciting new scientific discoveries, education offers and funding opportunities."



A calcite test of the planktonic foraminifera *Trilobatus sacculifer*, approximately 1mm in size collected during the GLOW cruise to the south west Indian Ocean.
Image credit: Sam Lichtin and Thomas Ezard



MRes Evolution programme director Dr Neil Gostling and PhD student Katy Williams place a three-dimensionally preserved fossil bird specimen on the rotation stage of the µ-VIS Custom Nikon 450/225kVp Hutch, the largest high energy microfocus CT scanner in Europe in an academic institution.

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

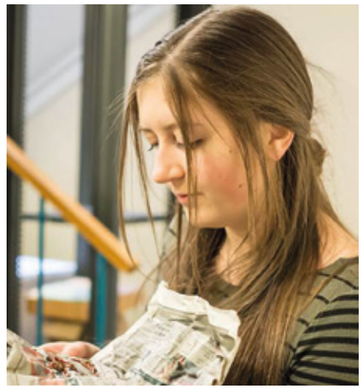
IMPROVING SUSTAINABILITY OF MARINE LIFE

An individual *Nereis diversicolor* (polychaete worm) surrounded by mucus.
Image credit: Alix Harvey. Marine Biological Association, Plymouth

Marine ecosystems can be extremely sensitive environments where the slightest change can cause a wide-ranging and detrimental effect.

Scientists around the globe are continually exploring ways to improve the long-term sustainability and adaptation of marine environments.

Innovative research, supported by the Institute for Life Sciences (IfLS), is using the technique of data driven biology to reveal the full impact a single alteration can have on life in our oceans.



PhD student Harriet Dale.

High throughput sequencing
Next Generation Sequencing (NGS) is one of the most significant technological advances of recent times, transforming mainstream healthcare by incorporating DNA sequencing into routine diagnostic use.

Scientists at the University of Southampton have a significant national profile in this clinical genomic sector.

Now novel research at Southampton is investigating how they can expand the use of high throughput genomic sequencing into the field of ocean sciences.

Unlocking the secrets of marine life
Southampton student Harriet Dale's postgraduate degree (PhD) is exploring the use of genomic sequencing techniques to understand more about the sustainability of marine life.

Harriet is a SPITFIRE PhD student based at the University of Southampton and the Marine Biological Association, in Plymouth.

Her PhD research focuses on the impact of invertebrate activity on nitrogen cycling in marine and estuarine sediments.

She said: "This nitrogen cycling releases nutrients into the water column to support the wider ecosystem. The activity of invertebrates living in sediments can alter the nitrogen cycling processes by changing the properties of the sediment.

"In order to fully understand the impact of invertebrate activity on nitrogen cycling we need to understand how different invertebrate traits impact key microbial groups."

IfLS support enables research expansion
Harriet's recent work is assessing the impact of invertebrate mucus (a potential source of organic matter) on sediment microbes and this research has been boosted with an IfLS award of £2,000 that she won at the recent Broad Interest Next Generation Sequencing (BINGS) network conference.

She was voted the winner from a shortlist of candidates who presented a three-minute outline of their research to DNA sequencing scientists from across the Wessex region.

Harriet said: "This IfLS funding will allow me to build on my research into the effects of this mucus. I will be using NGS technologies to assess the microbial communities associated with a key invertebrate species (the polychaete worm) and to discover what affect this could have on important ecosystem processes."

Potential impact
Climate change, pollution or the introduction of an invasive species can all cause the loss of invertebrate species from the sediment which in turn can affect ecosystem functions.

Harriet said: "In order to make accurate predictions we need to fully understand all of the invertebrate traits that could potentially affect specific ecosystem processes.

"The IfLS funding has given me a great opportunity to incorporate significantly more high throughput sequencing and bioinformatics into my PhD research.

"NGS sequencing can reveal the wider picture and provide a more detailed, holistic understanding of how sediment invertebrates affect microbial communities in the surrounding sediment, and what implications this could have on ecosystem processes and functioning."

Southampton – data driven biology opening up the oceans
The world's oceans are among the first environmental settings to which high throughput sequencing has been applied and Southampton's Ocean and Earth Science has its own high throughput sequencing facility.

Dr Phyllis Lam, Associate Professor in Microbial Biogeochemistry at Southampton, and one of Harriet's supervisors, said: "This is the first time that high throughput sequencing has been applied to the microbiome of a bioturbator. We hope that it will give us an important insight into how bioturbating invertebrates can alter environments and biogeochemical cycling.

"Although there have been a number of studies on sediment nitrogen cycling in the past, as well as those on general bioturbation, hardly ever have the two been brought together in the same study."

Associate Professor in Microbial Biogeochemistry Dr Phyllis Lam.

NEWS IN BRIEF

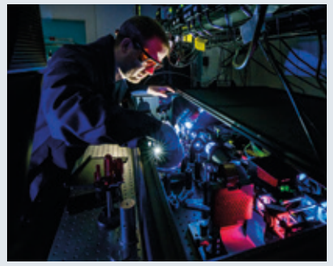
NATIONAL RECOGNITION FOR IfLS

IfLS researchers are set to play a key role in the development of the Rosalind Franklin Institute (RFI) - a new national centre of excellence in technology development and innovations.

The RFI will bring together academic and industry researchers from across the UK, including the University of Southampton, to develop disruptive technologies designed to tackle major challenges in health and life sciences, accelerate the discovery of new treatments for chronic diseases such as dementia that affect millions of people around the world, and deliver new jobs and long-term growth to the local and UK economies.

It will focus on the development of disruptive imaging methods and new chemical methods and strategies for drug discovery and will draw on expertise from UK institutions such as the University's Institute for Life Sciences.

IfLS Director Peter J S Smith said: "Our involvement with the Rosalind Franklin Institute is recognition by the wider world of the strength of our research and activities in the areas of disruptive and medical technologies."



Nanoscope: a novel ultra-high resolution optical microscope that uses visible light.

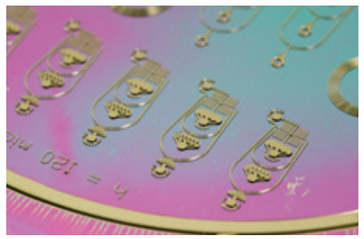
NEW TECHNOLOGIES AT THE FOREFRONT OF PRECISION CANCER MEDICINE

This year's IfLS Conference focused on technologies at the forefront of precision cancer medicine and was led by the IfLS' two Deputy Directors Professor Hywel Morgan and Professor Tim Elliott, also Director of Southampton's Centre for Cancer Immunology.

The conference drew together experts in the field of precision medicine to share their work on developing new technology and translating it into the clinic. It explored new approaches to diagnosis, imaging, targeted therapy and precision diagnostics.

Precision medicine is an emerging field of research that has opened new doors to the potential of helping doctors to deliver the right treatment to the right patients at the right time.

Tim said: "Currently, doctors do a great job of making sure patients receive treatments that are likely to make them better. Now they are beginning to incorporate molecular information into their diagnoses which will help guide them when making decisions about treatment. It will allow us to match existing and new therapies to individual patients more accurately and help us detect disease at an earlier stage."



Find out more visit:
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To find out more, visit:
www.southampton.ac.uk/ifls/news

NEW DIRECTOR FOR FORTISNET NETWORK

A new leader has been appointed for IfLS' FortisNet initiative – a world-class, interdisciplinary partnership combining expertise from academia, the clinic, industry and stakeholders.

Professor of Musculoskeletal Health, Jo Adams, will lead the network that fosters collaborative research and product development to help build stronger bones, heal fractures, replace lost limbs, prevent injury and enhance recovery.

Jo has an established international reputation for engaging the people and organisations who use research in clinical trial design, and leads the Patient and Public Involvement for the Arthritis Research UK Centre of Excellence for Sport, Exercise and Osteoarthritis.

She said: "It is my privilege to take on the leadership of FortisNet. The network has already established outstanding academic, industrial and clinical collaborations placing us in an excellent position to translate and implement the research conducted at Southampton. I look forward to further developing the inclusion of patients and service users, helping us to develop and disseminate our research."

Find out more visit:
www.southampton.ac.uk/fortisnet

TARGETING CANCER GENES

Research by an Institute for Life Sciences (IfLS) PhD student is contributing to the global fight against cancer.

Ane Gutierrez Aguirregabiria has been awarded a **Hilary Marsden IfLS studentship** for her research into using modified DNA to specifically control protein synthesis of targeted genes by altering mRNA structures.

IfLS supporter Chris Marsden has donated scholarships to the Institute as a legacy to his late wife Hilary who died from cancer in 2004. The money is used to fund two PhD studentships focusing on research to better understand cancer and childhood diseases.

Ane said: "I am honoured to receive one of these studentships recognising the importance of my research. It is a joint study between Chemistry, Biological Sciences and Medicine and will integrate the technologies related to DNA synthesis, gene expression, cell biology and molecular biology.

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

A sample of publications from our members: 2016 – 2017

The Institute is a catalyst for interdisciplinary research and training.
Working across the University campuses and the regional community, we aim to develop our collaborative models and address key societal issues and enterprise opportunities. The sample of publications is a selection from many hundreds produced by our members and illustrate the type of research being carried out under our strategic goals.

New Pathways to Health

Bayliss, L. E., Culliford, D., Monk, A. P., Glyn-Jones, S., Prieto-Alhambra, D., Judge, A., ... Price, A. J. (2017). *The effect of patient age at intervention on risk of implant revision after total replacement of the hip or knee: a population-based cohort study.* Lancet 389 (10077): 1424-1430. DOI: 10.1016/S0140-6736(17)30059-4

Bigler, J., Boedigheimer, M., Schofield, J. P. R., Skipp, P. J., Corfield, J., Rowe, A., ... Djukanovic, R. (2017). *A severe asthma disease signature from gene expression profiling of peripheral blood from U-BIOPRED cohorts.* American Journal of Respiratory and Critical Care Medicine 195 (10): 1311-1320. DOI: 10.1164/rccm.201604-0866OC

Blunt, M. D., Koehrer, S., Dobson, R. C., Larrayoz, M., Wilmore, S., Hayman, A., ... Steele, A. J. (2017). *The dual Syk/JAK inhibitor cerdulatinib antagonizes B-cell receptor and microenvironmental signaling in chronic lymphocytic leukemia.* Clinical Cancer Research 23 (9): 2313-2324. DOI: 10.1158/1078-0432.CCR-16-1662

Chen, R., Lee, W. Y-W., Zhang, X. H., Zhang, J. T., Lin, S., Xu, L. L., ... Jiang, X. (2017). *Epigenetic modification of the CCL5/CCR1/ERK axis enhances glioma targeting in dedifferentiation-reprogrammed BMSCs.* Stem Cell Reports 8 (3): 743-757. DOI: 10.1016/j.stemcr.2017.01.016

Ganesan, A-P., Clarke, J., Wood, O., Garrido-Martin, E. M., Chee, S. J., Mellows, T., ... Ottensmeier, C. H. (2017). *Tissue-resident memory features are linked to the magnitude of cytotoxic T cell responses in human lung cancer.* Nature Immunology 18 (8): 940-950. DOI: 10.1038/ni.3775

Gao, Y., Arkwright, P. D., Darley, R., Cazaly, A., Harrison, R. J., Mant, A., ... Williams, A. (2016). *Bone marrow transplantation for MHC class I deficiency corrects T-cell immunity but dissociates natural killer cell repertoire formation from function.* Journal of Allergy and Clinical Immunology 138 (6): 1733-1736.e2. DOI: 10.1016/j.jaci.2016.06.029

Holmes, C., Jun, G., Ibrahim-Verbaas, C. A., Vronskaya, M., Lambert, J. C., Chung, J., ... Bellenguez, C. (2016). *A novel Alzheimer disease locus located near the gene encoding tau protein.* Molecular Psychiatry 21 (1): 108-117. DOI: 10.1038/mp.2015.23

Jamil, K. M., Hydes, T. J., Cheent, K. S., Cassidy, S. A., Traherne, J. A., Jayaraman, J., ... Khakoo, S. I. (2016). *STAT4-associated natural killer cell tolerance following liver transplantation.* Gut 66 (2): 352-361. DOI: 10.1136/gutjnl-2015-309395

Lockett, G. A., Soto-Ramírez, N., Ray, M. A., Everson, T. M., Xu, C-J., Patil, V. K., ... Holloway, J. W. (2016). *Association of season of birth with DNA methylation and allergic disease.* Allergy 71 (9): 1314-1324. DOI: 10.1111/all.12882

Olmos-Alonso, A., Schetters, S. T. T., Sri, S., Askew, K., Mancuso, R., Vargas-Caballero, M., ... Gomez-Nicola, D. (2016). *Pharmacological targeting of CSF1R inhibits microglial proliferation and prevents the progression of Alzheimer's-like pathology.* Brain 139 (3): 891-907. DOI: 10.1093/brain/awv379

Ottensmeier, C. H., Perry, K. L., Harden, E. L., Stasakova, J., Jenei, V., Fleming, J., ... Thirdborough, S. M. (2016). *Upregulated glucose metabolism correlates inversely with CD8+ T cell infiltration and survival in squamous cell carcinoma.* Cancer Research 76 (14): 4136-4148. DOI: 10.1158/0008-5472.CAN-15-3121

Pengelly, R., Greville-Heygate, S., Schmidt, S., Seaby, E. G., Jabalameli, M. R., Mehta, S. G., ... Baralle, D. (2016). *Mutations specific to the Rac-GEF domain of TRIO causes intellectual disability and microcephaly.* Journal of Medical Genetics, 53 (11): 735-742. DOI: 10.1136/jmedgenet-2016-103942

Rose-Zerilli, M., Gibson, J., Wang, J., Tapper, W., Davis, Z., Parker, H., ... Strefford, J. (2016). *Longitudinal copy number, whole exome and targeted deep sequencing of 'good risk' IGHV-mutated CLL patients with progressive disease.* Leukemia 30 (6): 1301-1310. DOI: 10.1038/leu.2016.10

Sharp, B., Paquet, E., Naef, F., Bafna, A., & Wijnen, H. (2017). *A new promoter element associated with daily time keeping in Drosophila.* Nucleic Acids Research 45 (11): 6459-6470. DOI: 10.1093/nar/gkx268

Tovar, C., Pye, R. J., Kreiss, A., Cheng, Y., Brown, G. K., Darby, J., ... Woods, G. M. (2017). *Regression of devil facial tumour disease following immunotherapy in immunised Tasmanian devils.* Scientific Reports 7: 43827. DOI: 10.1038/srep43827

Walker, N. F., Wilkinson, K. A., Meintjes, G., Tezera, L. B., Goliath, R., Peyper, J. M., ... Elkington, P. T. (2017). *Matrix degradation in HIV-1-associated tuberculosis and tuberculosis immune reconstitution inflammatory syndrome: a prospective, observational study.* Clinical Infectious Diseases 10 (1): 121-132. DOI: 10.1093/cid/cix231

Walker, W., Jackson, C., Allan, R., Collins, S. A., Kelso, M. J., Rineh, A., ... Hall-Stoodley, L. (2017). *Primary ciliary dyskinesia ciliated airway cells show increased susceptibility to Haemophilus influenzae biofilm formation.* European Respiratory Journal 50 (3): 1700612. DOI: 10.1183/13993003.00612-2017

Wang, X., Yu, M., Zhao, K., He, M., Ge, W., Sun, Y., ... Hu, Y. (2016). *Up-regulation of MiR-205 under hypoxia promotes epithelial-mesenchymal transition by targeting ASPP2.* Cell Death and Disease 7: e2517. DOI: 10.1038/cddis.2016.412

Whitwell, H., Mackay, R-M., Elgy, C., Morgan, C., Griffiths, M., Clark, H., ... Madsen, J. (2016). *Nanoparticles in the lung and their protein corona: the few proteins that count.* Nanotoxicology 10 (9): 1385-1394. DOI: 10.1080/17435390.2016.1218080

Yeomans, A., Thirdborough, S. M., Valle-Argos, B., Linley, A., Krysov, S., Hidalgo, M. S., ... Packham, G. (2016). *Engagement of the B-cell receptor of chronic lymphocytic leukemia cells drives global and MYC-specific mRNA translation.* Blood 127 (4): 449-457. DOI: 10.1182/blood-2015-07-660969

Life Technologies

Bielecka, M. K., Tezera, L. B., Zmijan, R., Drobniewski, F., Zhang, X., Jayasinghe, S., & Elkington, P. (2017). *A bioengineered three-dimensional cell culture platform integrated with microfluidics to address antimicrobial resistance in tuberculosis.* mBio 8 (1): e02073-16. DOI: 10.1128/mBio.02073-16

Boags, A., Hsu, P., Samsudin, F., Bond, P. J., & Khalid, S. (2017). *Progress in molecular dynamics simulations of Gram-negative bacterial cell envelopes.* The Journal of Physical Chemistry Letters, 8 (11): 2513-2518. DOI: 10.1021/acs.jpclett.7b00473

Busschaert, N., Thompson, S., & Hamilton, A. D. (2017). *An alpha-helical peptidomimetic scaffold for dynamic combinatorial library formation.* Chemical Communications 53 (2): 313-316. DOI: 10.1039/C6CC07787K

He, P., Katis, I., Eason, R., & Sones, C. (2016). *Laser direct-write for fabrication of three-dimensional paper-based devices.* Lab on a Chip 16: 3296-3303. DOI: 10.1039/c6lc00789a

Huefner, A., Kuan, W-L., Müller, K. H., Skepper, J. N., Barker, R. A., & Mahajan, S. (2016). *Characterization and visualization of vesicles in the endo-lysosomal pathway with surface-enhanced raman spectroscopy and chemometrics.* ACS Nano 10 (1): 307-316. DOI: 10.1021/acsnano.5b04456

Janeczek AA, Scarpa E, Horrocks MH, Tare RS, Rowland CA, Jenner D, Newman TA, Oreffo RO, Lee SF, Evans ND. (2017) *PEGylated liposomes associate with Wnt3A protein and expand putative stem cells in human bone marrow populations.* Nanomedicine (Lond) 12(8):845-863. doi: 10.2217/nnm-2016-0386

IfLS Publications 2016-17

Junaid, T., Bradley, R., Lewis, R., Aplin, J., & Johnstone, E. (2017). *Whole organ vascular casting and microCT examination of the human placental vascular tree reveals novel alterations associated with pregnancy disease.* Scientific Reports 7: 4144. DOI: 10.1038/s41598-017-04379-0

Koebernick, N., Daly, K., Keyes, S., George, T. I. S., Brown, L., Raffan, A., ... Roose, T. (2017). *High-resolution synchrotron imaging shows that root hairs influence rhizosphere soil structure formation.* New Phytologist 216 (1): 124-135. DOI: 10.1111/nph.14705

Kukwikila, N. M., Gale, N., El-Sagheer, A. H., Brown, T., & Tavassoli, A. (2017). *Assembly of a biocompatible triazole-linked gene by one-pot click-DNA ligation.* Nature Chemistry DOI: 10.1038/nchem.2850

Marth, G., Hartley, A. M., Reddington, S. C., Sargisson, L. L., Parcollet, M., Dunn, K. E., ... Stulz, E. (2017). *Precision templated bottom-up multiprotein nanoassembly through defined click chemistry linkage to DNA.* ACS Nano 11 (5): 5003-5010. DOI: 10.1021/acsnano.7b01711

Morgan, J. M., Kitt, S., Gill, J., McComb, J. M., Ng, G. A., Raftery, J., ... Cowie, M. (2017). *Remote management of heart failure using implantable electronic devices.* European Heart Journal 38 (30): 2352-2360. DOI: 10.1093/eurheartj/ehx227

Nightingale, A., Evans, G., Xu, P., Jae Kim, B., Hassan, S-U., & Niu, X. (2017). *Phased peristaltic micropumping for continuous sampling and hardcoded droplet generation.* Lab on a Chip 17 (6): 1149-1157. DOI: 10.1039/C6LC01479H

Smith, S. J., Emery, R., Pitsillides, A., Clarkin, C. E., & Mahajan, S. (2017). *Detection of early osteogenic commitment in primary cells using Raman spectroscopy.* The Analyst 142 (11): 1962-1973. DOI: 10.1039/C6AN02469F

Spencer, D., Caselli, F., Bisegna, P., & Morgan, H. (2016). *High accuracy particle analysis using sheathless microfluidic impedance cytometry.* Lab on a Chip 16 (13): 2467-2473. DOI: 10.1039/C6LC00339G

Tang, D., Tare, R. S., Yang, L-Y., Williams, D. F., Ou, K-L., & Oreffo, R. (2016). *Biofabrication of bone tissue: approaches, challenges and translation for bone regeneration.* Biomaterials 83: 363-382. DOI: 10.1016/j.biomaterials.2016.01.024

van Straaten, K. E., A. Kuttiyatveetil, J. R., Sevrain, C. M., Villaume, S. A., Jimenez-Barbero, J., Linclau, B., ... Sanders, D. A. R. (2015). *Structural basis of ligand binding to UDP-galactopyranose mutase from mycobacterium tuberculosis using substrate and tetrafluorinated substrate analogs.* Journal of the American Chemical Society 137 (3): 1230-1244. DOI: 10.1021/ja511204p

Xavier, M., Oreffo, R. O. C., & Morgan, H. (2016). *Skeletal stem cell isolation: a review on the state-of-the-art microfluidic label-free sorting techniques.* Biotechnology Advances 34 (5): 908-923. DOI: 10.1016/j.biotechadv.2016.05.008

Global Change: Systems & Cycles

Amano, T., Coverdale, R., & Peh, K. S-H. (2016). *The importance of globalisation in driving the introduction and establishment of alien species in Europe.* Ecography 39 (11): 1118-1128. DOI: 10.1111/ecog.01893

Anagnostou, E., John, E. H., Edgar, K. M., Foster, G. L., Ridgwell, A., Inglis, G. N., ... Pearson, P. N. (2016). *Changing atmospheric CO_2 concentration was the primary driver of early Cenozoic climate.* Nature 533 (7603): 380-384. DOI: 10.1038/nature17423

Browning, T., Achterberg, E., Yong, J., Rapp, I., Utermann, C., Engel, A., & Moore, C. (2017). *Iron limitation of microbial phosphorus acquisition in the tropical North Atlantic.* Nature Communications 8: 15465. DOI: 10.1038/ncomms15465

Burgess, S. J., Granero-Moya, I., Grangé-Guermente, M. J., Boursnell, C., Terry, M. J., & Hibberd, J. M. (2016). *Ancestral light and chloroplast regulation form the foundations for C4 gene expression.* Nature Plants 2 (11): 16161. DOI: 10.1038/nplants.2016.161

Mcleod, E., Szuster, B., Hinkel, J., Tompkins, E. L., Marshall, N., Downing, T., ... Rubinoff, P. (2016). *Conservation organizations need to consider adaptive capacity: why local input matters.* Conservation Letters 9 (5): 351-360. DOI: 10.1111/conl.12210

Palma, E., Catford, J., Corlett, R. T., Duncan, R. P., Hahs, A. K., McCarthy, M. A., ... Vesk, P. A. (2016). *Functional trait changes in the floras of 11 cities across the globe in response to urbanization.* Ecography 40 (7): 875-886. DOI: 10.1111/ecog.02516

Schmidt, K., Schlosser, C., Atkinson, A., Fielding, S., Venables, H. J., Waluda, C. M., & Achterberg, E. P. (2016). *Zooplankton gut passage mobilizes lithogenic iron for ocean productivity.* Current Biology 26 (19): 2667-2673. DOI: 10.1016/j.cub.2016.07.058

Solan, M., Hauton, C., Godbold, J. A., Wood, C. L., Leighton, T. G., & White, P. (2016). *Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties.* Scientific Reports 6: 20540. DOI: 10.1038/srep20540

Human Nexus

Algeo, N., Hunter, D., Cahill, A., Dickson, C., & Adams, J. (2017). *Usability of a digital self-management website for people with osteoarthritis: A UK patient and public involvement study.* International Journal of Therapy and Rehabilitation 24 (2): 78-82. DOI: 10.12968/ijtr.2017.24.2.78

Hall, W., & Hendler, J. (2016). *Science of the World Wide Web.* Science 354 (6313): 703-704. DOI: 10.1126/science.aai9150

Mossotto, E., Ashton, J. J., Coelho, T., Beattie, R. M., Macarthur, B. D., & Ennis, S. (2017). *Classification of paediatric inflammatory bowel disease using machine learning.* Scientific Reports 7: 2427. DOI: 10.1038/s41598-017-02606-2

Stella, M., Beckage, N., & Brede, M. (2017). *Multiplex lexical networks reveal patterns in early word acquisition in children.* Scientific Reports 7: 46730. DOI: 10.1038/srep46730

Watson, R., & Szathmary, E. (2016). *How can evolution learn?* Trends in Ecology & Evolution 31 (2): 147-157. DOI: 10.1016/j.tree.2015.11.009

Yamamoto, K., Ishii, M., Inoue, Y., Hirokawa, F., Macarthur, B., Nakamura, A., ... Uchiyama, K. (2016). *Prediction of postoperative liver regeneration from clinical information using a data-led mathematical model.* Scientific Reports 6: 34214. DOI: 10.1038/srep34214.

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