# INNOVATION insights

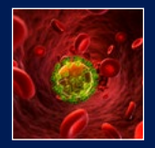
THE LATEST INNOVATIONS, COLLABORATIONS AND TECHNOLOGY TRANSFER
FROM THE UNIVERSITY OF OXFORD

ISSUE 11 JAN 2019

# CAN AI DIAGNOSE HEART DISEASE?

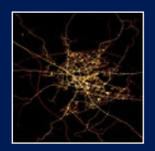
Oxford University spinout uses AI to identify people at risk of heart disease

Therapeutic potential of modified gene molecules ▶



HIV Vaccine ▶

Hepatitis C Vaccine ▶



Netmob 2019 ▶

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# INNOVATION insights

## CONTENTS

# A new year of innovation at Oxford University

## Delivering impact from academic discovery

Welcome to our first issue of 2019. All the signs are that this will be a great year, with our activities reinvigorated by new approaches and initiatives such as Social Enterprise (the focus of our last edition). For a overview of all the ways we are enabling the University community to maximise the impact of Oxford's research and expertise see our latest **Annual Review** which features examples from many of the activities that OUI manages.

In this issue of *Innovation Insights* we feature Ultromics, a recent spinout that is applying AI to achieve better diagnosis of heart disease by interpreting echocardiography images with accuracy significantly better than that of human doctors.

Finally, we do value your feedback. Please tell us how Innovation Insights helps you, and how it could be better by completing a short survey **here**.


ANNUAL REVIEW ▶

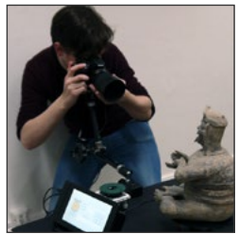
SHORT SURVEY ▶

# News

**OUI Incubator relaunches**

Oxford University Innovation Incubator unveils a new deal on equity and access to finance through the OUI Future Fusion programme.

FULL ARTICLE ▶



**Oxford spinout offers automated 3D digitisation of objects**

PalaeoPi, a spinout from the University of Oxford has developed a device which is capable of digitising small to medium sized objects rapidly and accurately.

FULL ARTICLE ▶

**Predicting and preventing heart attacks**

Oxford spinout Caristo Diagnostic uses new coronary CT image analysis technology to identify patients at risk of heart attacks years before they occur.

FULL ARTICLE ▶

**OUI updates and Q4 activity**

Oxford University Innovation breaks its own spinout generation record as the spinout community attracts more investment than ever before.

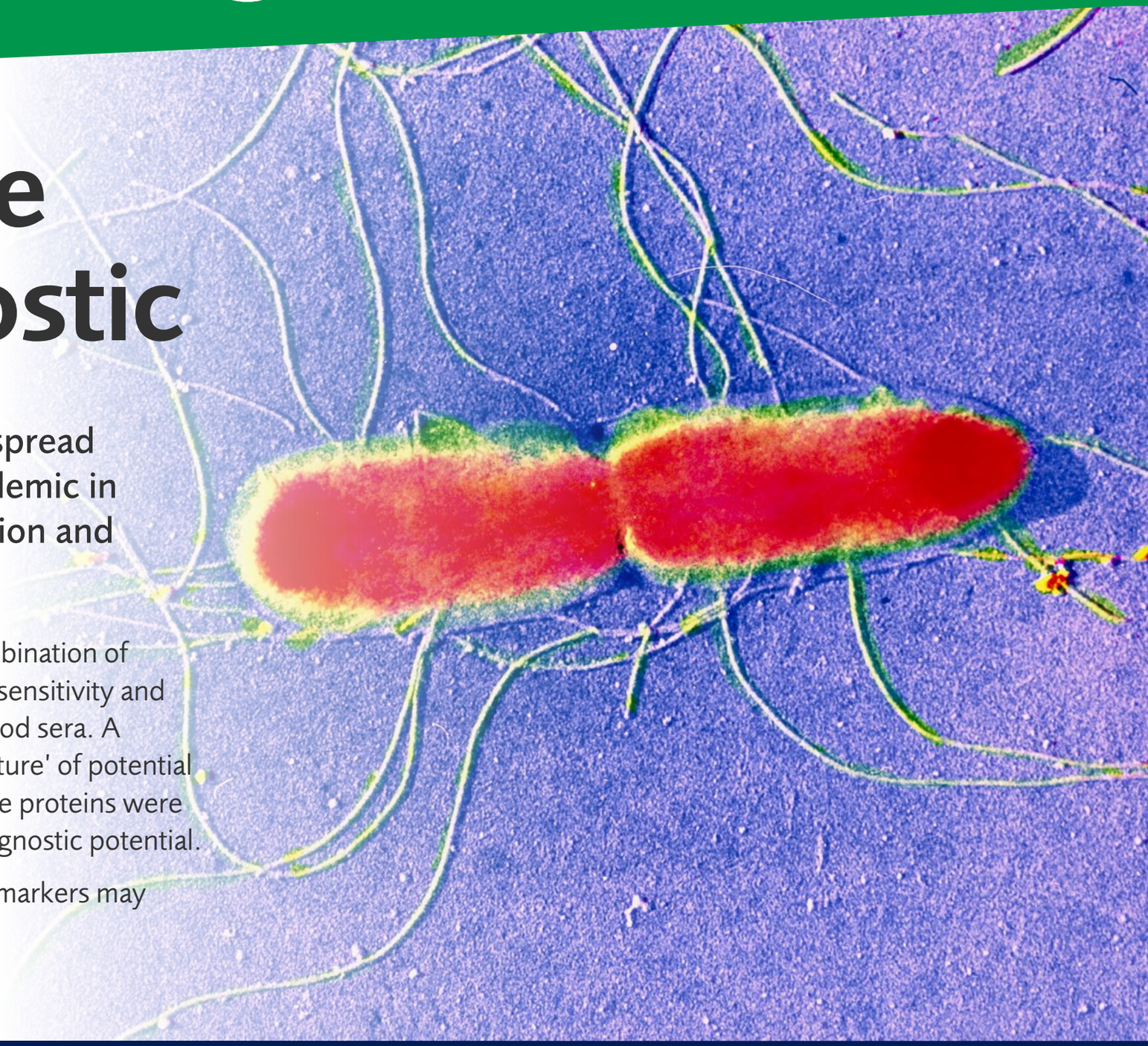
FULL ARTICLE ▶

**Quantum sensor technology**

Oxford HighQ have combined nanoparticle sensors with 'quantum' sensors which are 10,000 times more sensitive than current optical sensing technologies.

FULL ARTICLE ▶

# Rapid, sensitive typhoid diagnostic



Typhoid fever, a bacterial infection that can spread quickly through food and water, remains endemic in many developing countries with poor sanitation and limited access to clean water.

Oxford researchers based in Vietnam have identified a combination of Salmonella typhi biomarkers, which provide a high level of sensitivity and specificity for the rapid diagnosis of typhoid fever using blood sera. A previously performed proteomic analysis identified a 'signature' of potential biomarkers during active typhoid infection.  Several of these proteins were systematically chosen by the researchers to assess their diagnostic potential.

In addition to providing more accurate diagnosis, these biomarkers may also be suitable candidates for a vaccine.

FULL WEB PROFILE ▶

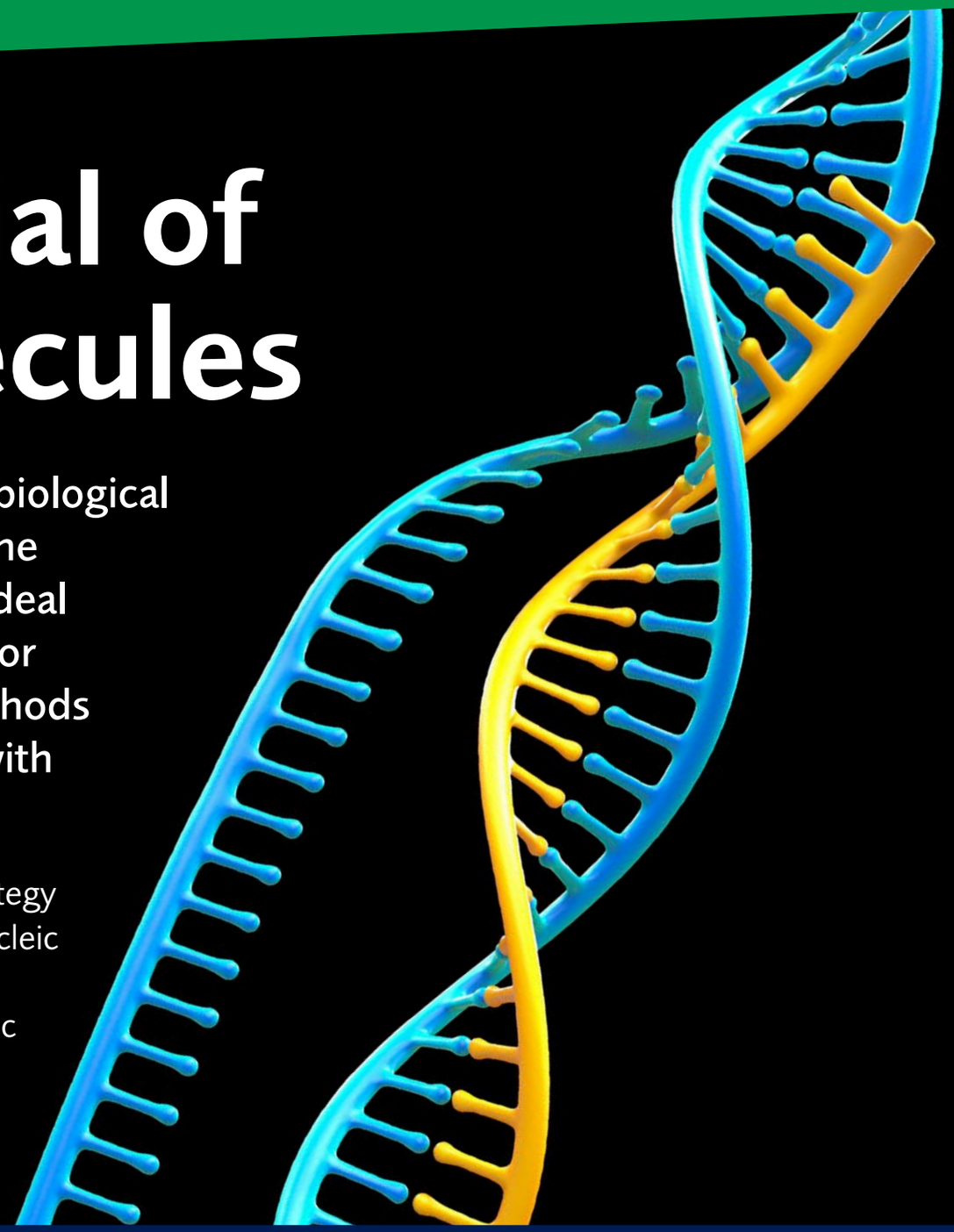
# Diagnosis and management of AML

Acute Myeloid Leukaemia (AML) is a type of aggressive blood cancer, with several molecular sub-types. Current treatments aim to reduce levels of leukaemic stem cells (LSC), which are thought to be responsible for sustaining the disease and lead to relapse. However, until now, no technologies were available that could determine the molecular sub-type of AML present in the patient (to predict disease course and inform treatment with targeted therapeutics) and detect and monitor the levels of these remaining LSCs.

Driven by this unmet need, researchers at the University of Oxford have discovered combinations of cell-surface biomarkers which are capable of meeting both objectives. This combination is currently under development to be used as a diagnostic and prognostic screening tool to fight against AML relapse and to improve management of the disease.

FULL WEB PROFILE ▶

# Therapeutic potential of modified gene molecules

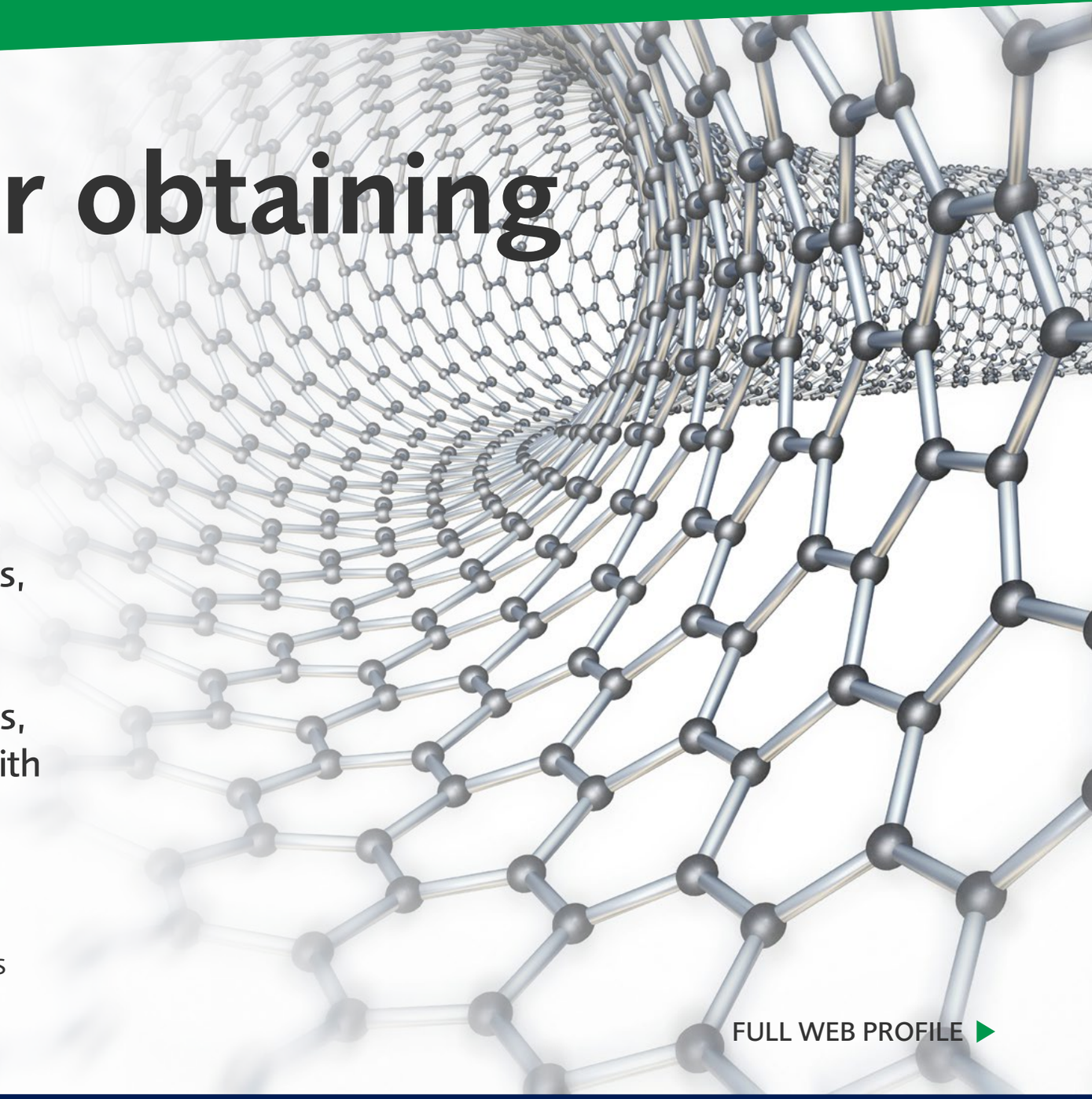


Nucleic acids (RNA and DNA) have a plethora of functions in biological systems, many of which are only recently being uncovered. The ubiquity of this unique class of biomolecules makes them an ideal candidate for use as cutting-edge pharmaceuticals as well as for applications in forensic testing and gene editing. Efficient methods to synthesise robust, bespoke and non-natural nucleic acids with new functionality are therefore highly sought after.

Researchers at the University of Oxford have developed a chemical synthesis strategy for producing DNA incorporating non-natural backbone structures and locked nucleic acid (LNA) sugars which convey desirable properties such as more selective and robust binding to complementary nucleic acids and greater resistance to enzymatic degradation. These systems have potential for use as therapeutic agents.

FULL WEB PROFILE ▶

# Novel method for obtaining conductive films

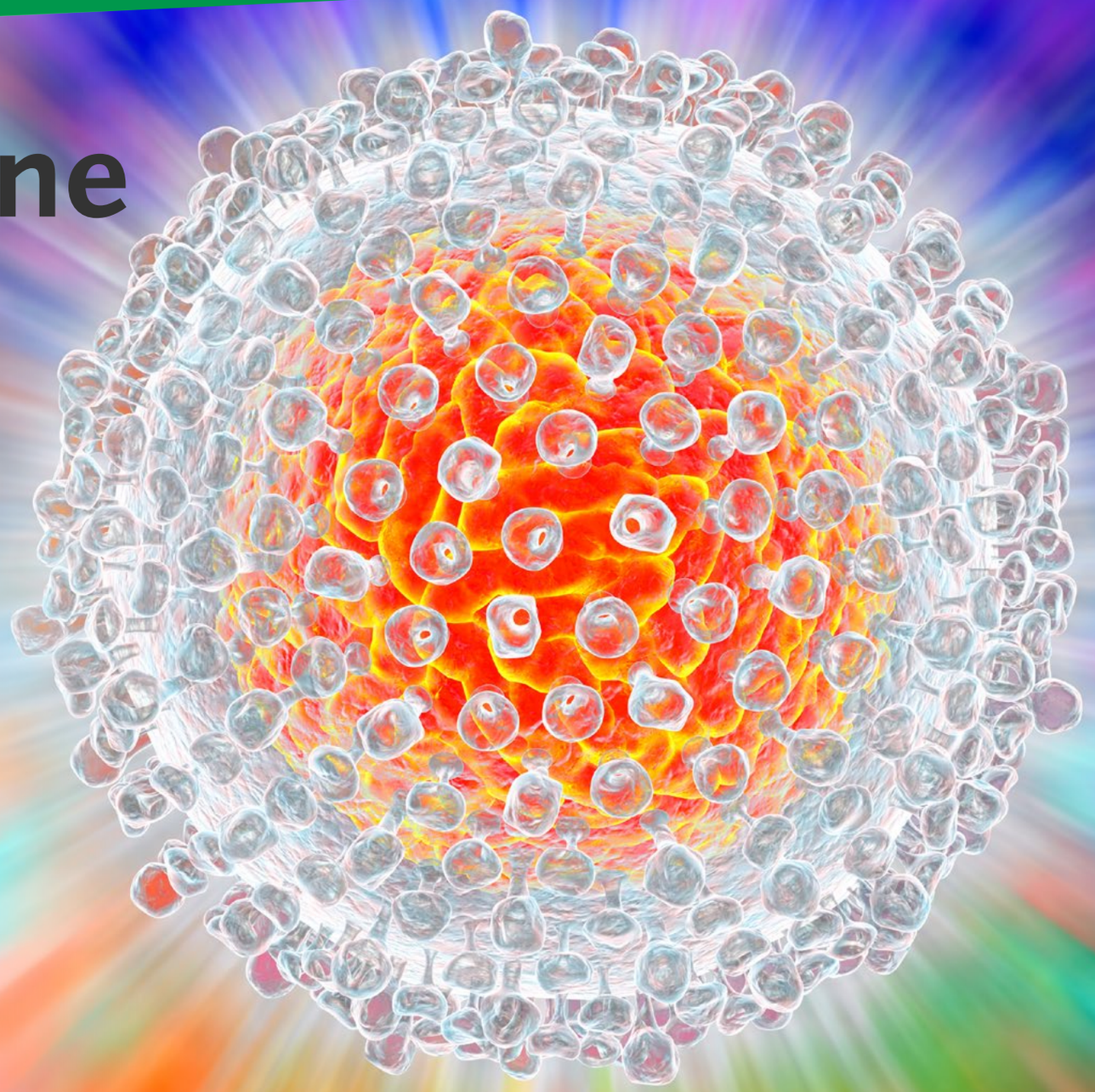


Carbon nanotubes (CNTs) have attracted a lot of attention for their potential use in electronic and energy-related devices. Conductive carbon nanotube films are expected to be applied in anti-static materials, electromagnetic interference shielding materials and other opto-electronic devices like solar cells. Poor solubility of CNTs in organic and aqueous solvents has, so far, been overcome with non-covalent wrapping with conjugated polymers, but at high cost.

Oxford researchers have developed a novel method for obtaining conductive CNT films with inexpensive, non-conjugated polymers. The films show high transparency and similar conductivities to previous conductive CNT films using conjugated polymers.

FULL WEB PROFILE ▶

# Hepatitis C Vaccine



Hepatitis C virus (HCV) infection is a major global health concern - 170 million people are infected worldwide, with 3 – 4 million new infections annually. Many chronically infected patients develop complications of liver disease that include hepatocellular cancer, liver cirrhosis and liver failure.

Despite advances in HCV treatment, a prophylactic vaccine remains the most cost-effective and realistic means to significantly reduce the worldwide mortality and morbidity associated with persistent HCV infection.

Researchers at the Jenner Institute have developed an HCV vaccine using non-replicating viral-vectored vaccines to induce T-cell responses against a single immunogen incorporating the most conserved proteins of HCV, including non-structural proteins.

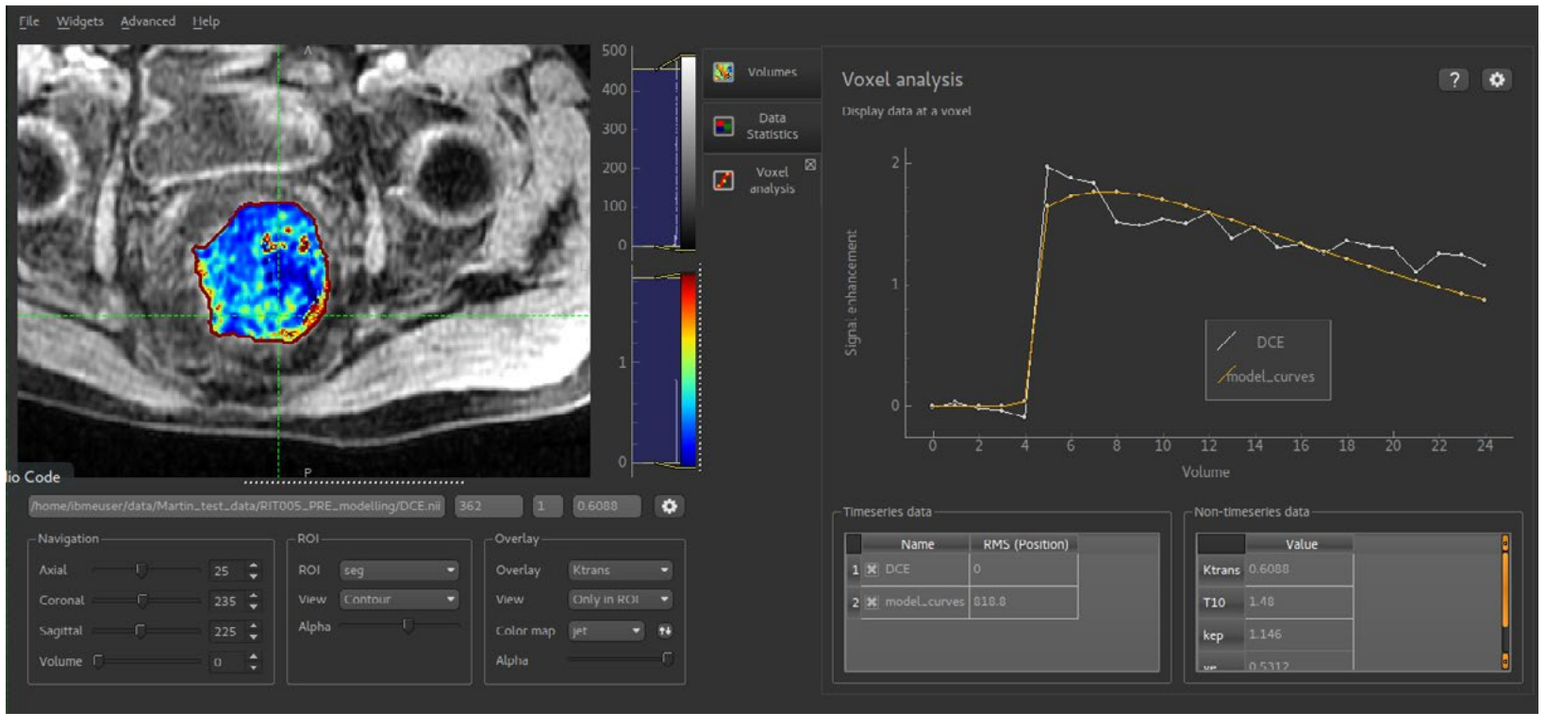
FULL WEB PROFILE ▶

# Improved analysis of imaging data

Quantiphyse is built around the concept of making spatially resolved measurements of physical or physiological processes from imaging data using either model-based or model-free methods, in a large part exploiting Bayesian inference technique.

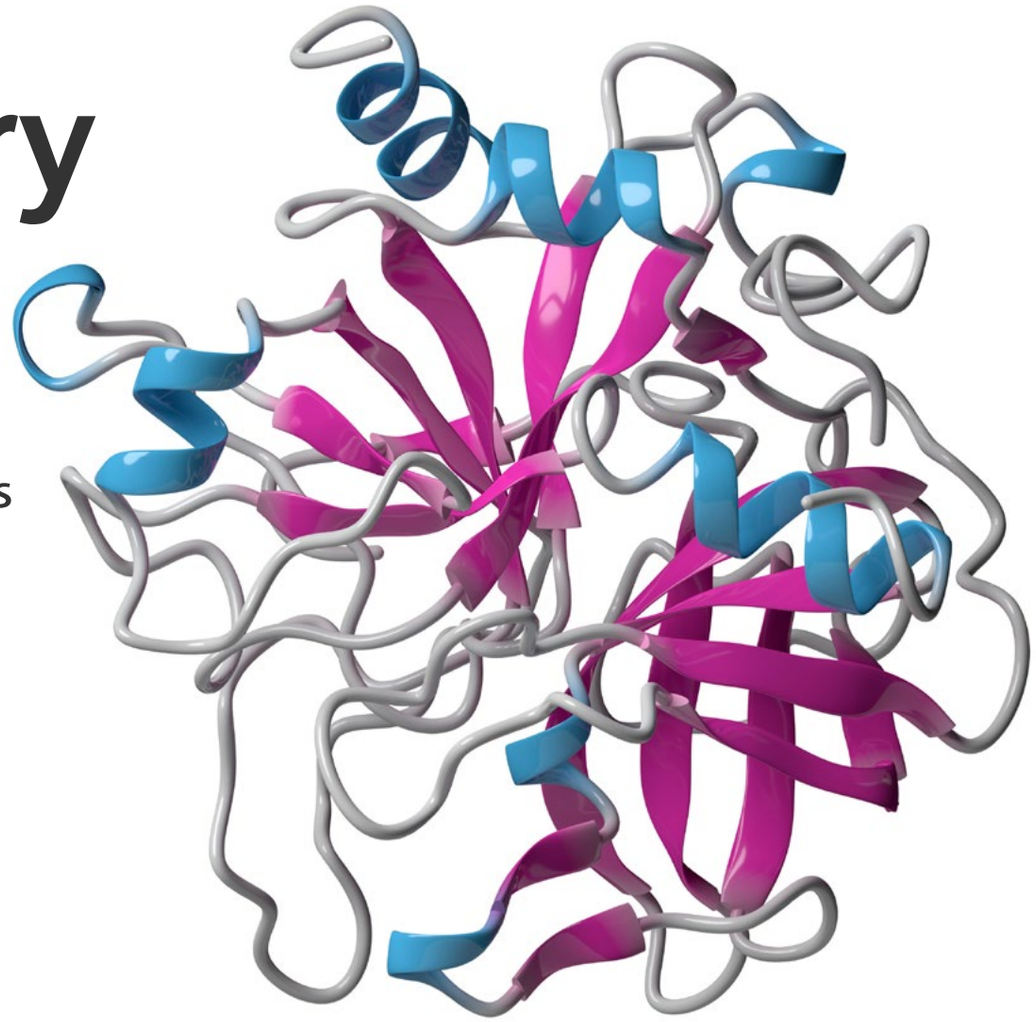
Over the years, medical imaging techniques have undergone major advances. The most common types of imaging include X-rays, ultrasound, CT scans and MRI.

Quantiphyse is an advanced visual tool for 3D and 4D biomedical imaging data. It is particularly suited for physiological or functional imaging data comprised of multi volumes in a 4D (time) series and /or multimodal imaging data. The applications include highlighting features in the brain and cancerous growths associated with the underlying physiology.




FULL WEB PROFILE ▶

# Using magnetism for targeted drug delivery

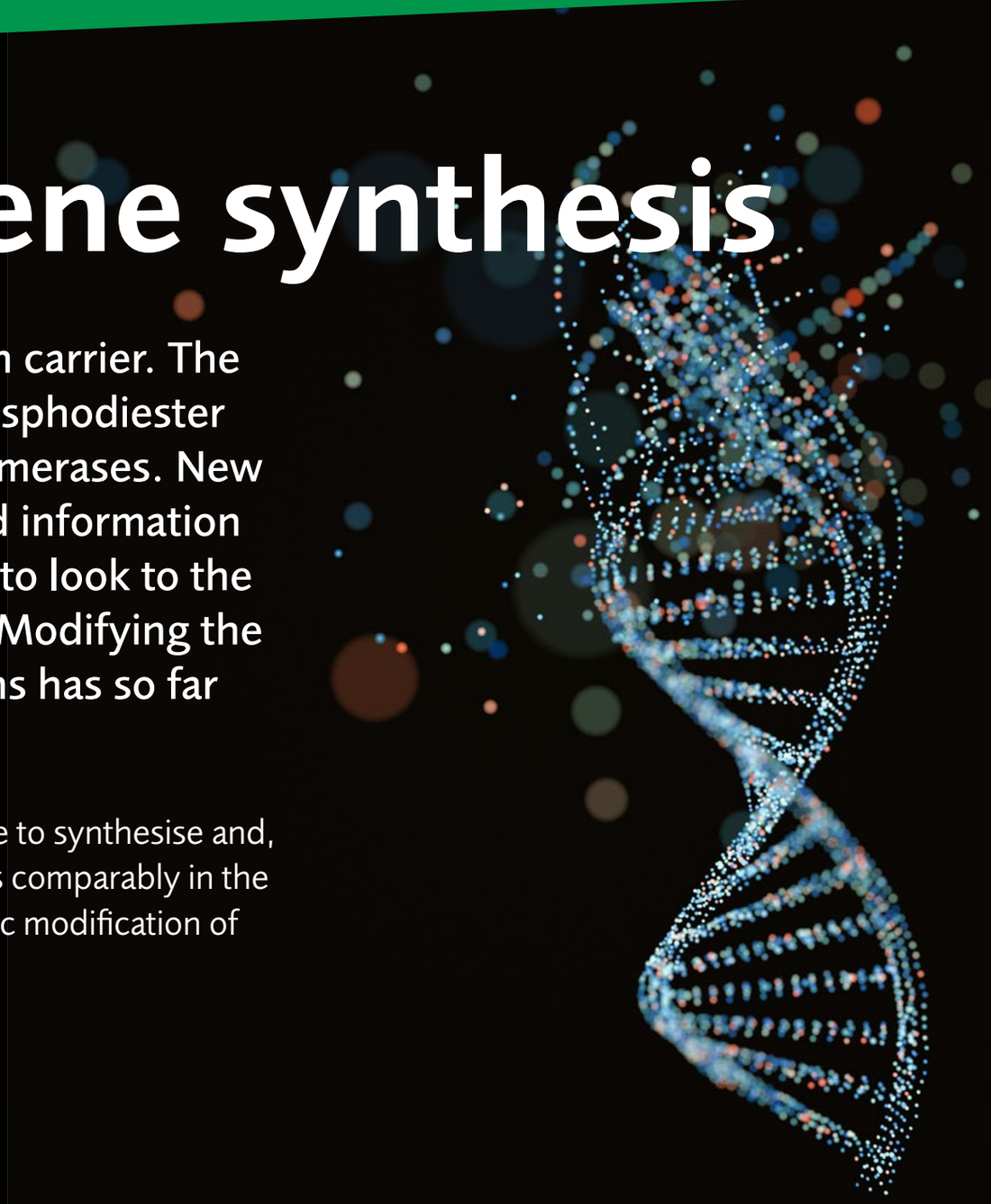


**A pseudoaneurysm, sometimes called a false aneurysm, occurs when a blood vessel wall is injured, and the blood is contained by the surrounding tissues. This can occur when blood escapes from the lumen of an artery through a defect in one or more layers of the arterial wall and forms a localised pocket of flow either beneath the outer wall of the artery or in the surrounding tissues.**

Oxford researchers have developed a method to induce thrombosis (clotting) in specific anatomical areas for the treatment of conditions such as pseudoaneurysms. The drug delivery method uses magnetic microbubbles to guide the thrombin into the pseudoaneurysm. The use of magnetic microbubbles can deliver thrombin into a pseudoaneurysm more accurately and effectively resulting in a site-specific delivery method, very similar to ultrasound. This will avoid any complications from injecting the thrombin into the wrong part of the blood vessel and risking a distant thrombosis.

FULL WEB PROFILE ▶

# A new method of gene synthesis



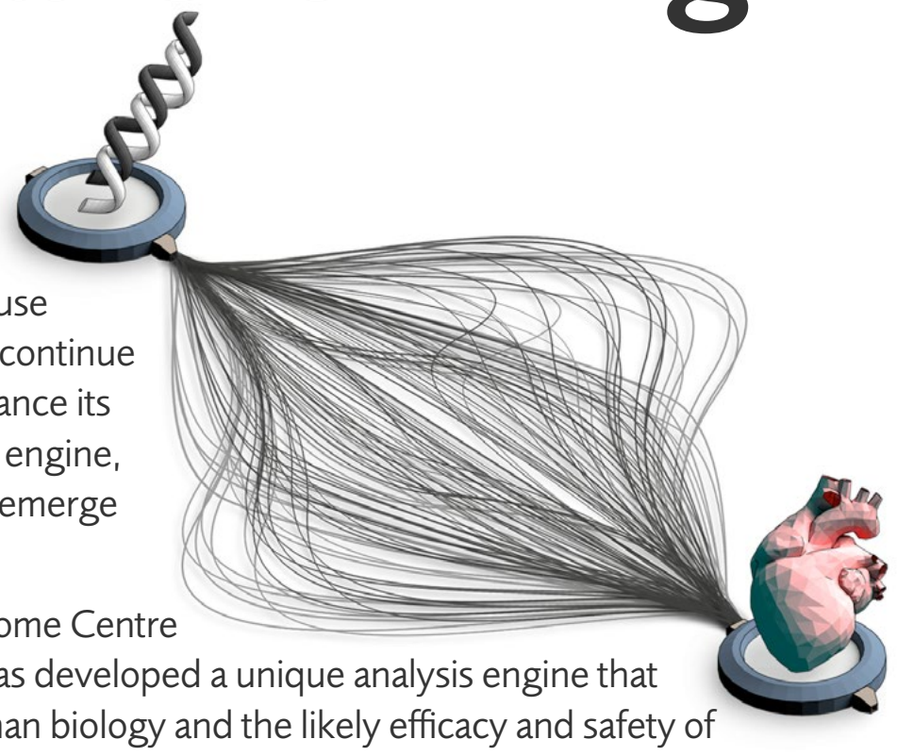
DNA structure is closely linked to its function as an information carrier. The orientation and spacing of nucleobases, as dictated by the phosphodiester backbone, ensures that DNA can be rapidly read by DNA polymerases. New areas of science have emerged where editing the structure and information content of DNA has become crucial and scientists have begun to look to the phosphodiester backbone as a potential customisation target. Modifying the backbone, whilst maintaining the correct enzymatic interactions has so far proven difficult.

Oxford researchers have developed a DNA backbone modification, which is simple to synthesise and, due to its similar size and shape to the classical phosphodiester backbone, behaves comparably in the presence of DNA polymerases. The technology allows for the accurate, site-specific modification of long strands of DNA, without dramatically affecting its function.

FULL WEB PROFILE ▶

# Genetic information transforming drug development

**The world-class team at Genomics plc, a data science company specialising in the use of human genetic information to improve drug development, recently announced the successful completion of a second close of its Series B financing round. The second close raised an additional £8 million, bringing the total raised in the round to £33 million. The new investors - Foresite Capital and F-Prime Capital - are large US healthcare investment companies with proven track records of building large, successful healthcare companies.**



Genomics plc, an Oxford Innovation Society member, will use the proceeds of this fundraise to continue its expansion, to continue to enhance its powerful database and analytical engine, and to pursue opportunities that emerge in this fast-growing space.

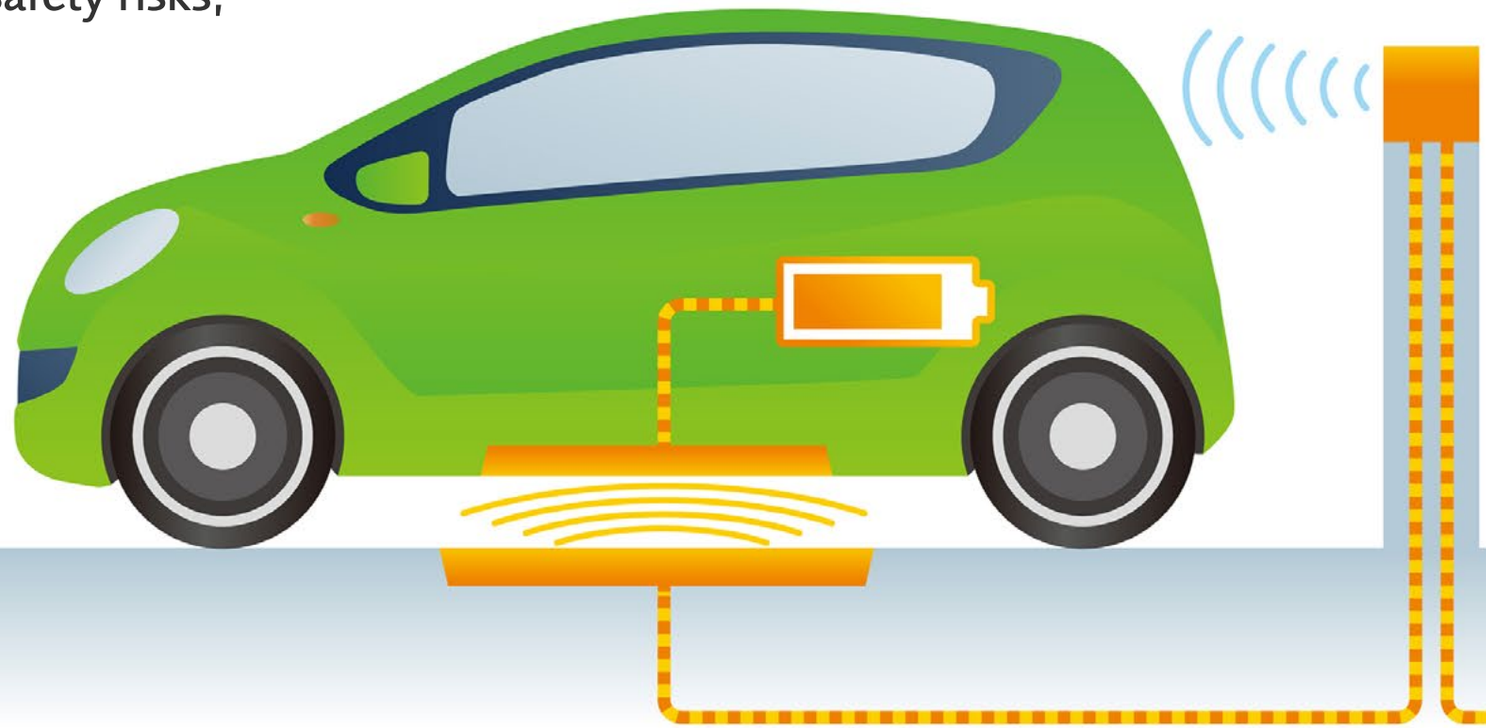
Spun out in 2014 from the Wellcome Centre for human genetics, Genomics has developed a unique analysis engine that uses genetics to understand human biology and the likely efficacy and safety of potential novel medicines. The Genomics' engine is the largest of its kind in the world and it uses breakthrough proprietary machine learning and statistical algorithms to predict the impact of therapeutic interventions.

If you're interested to learn more about this growing company, and the opportunities available to join this amazing team, please go to: www.genomicsplc.com/work-with-us/ ▶

# Safe wireless power transfer

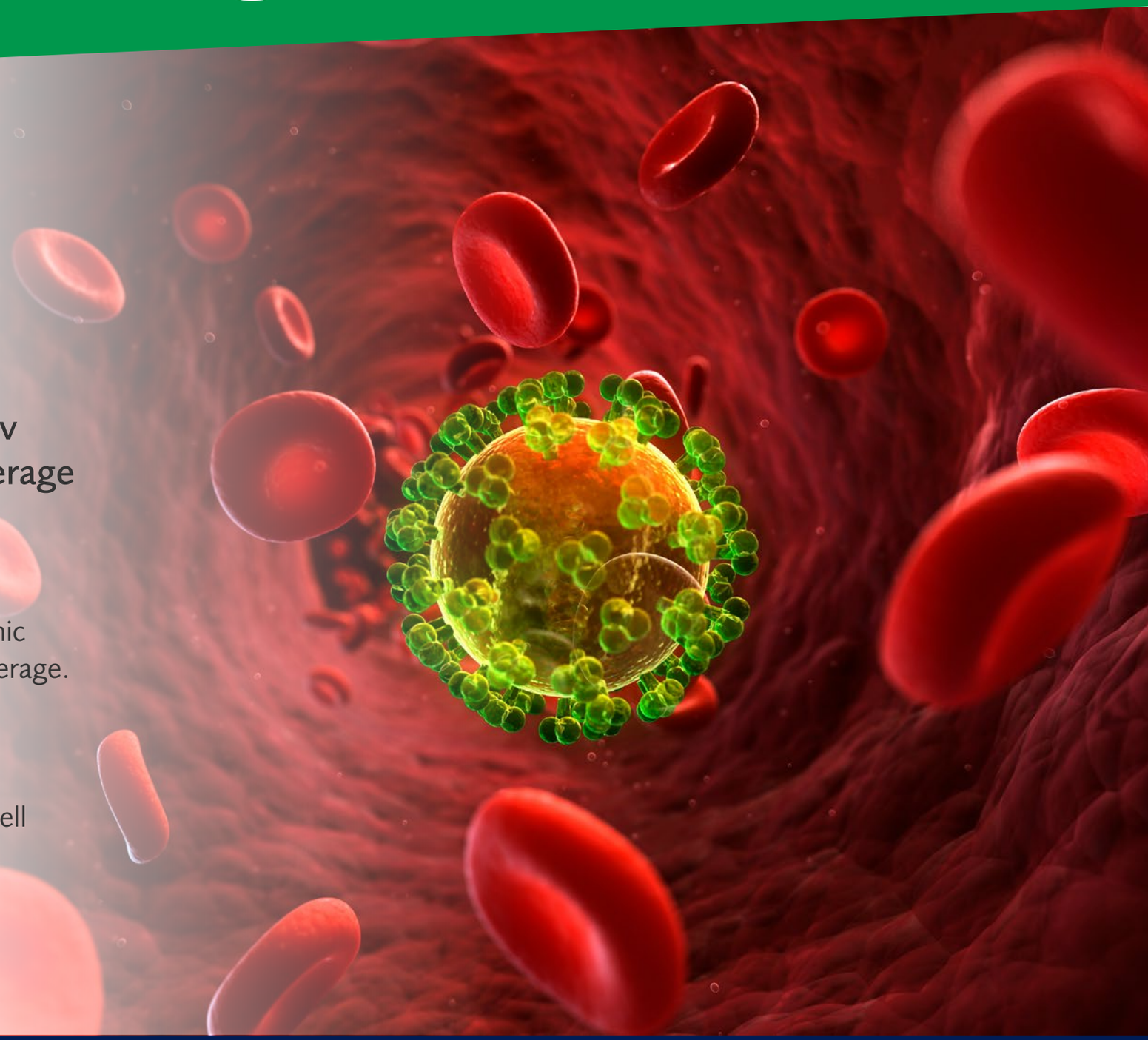
Wireless power transfer (WPT) is likely to be widely adopted throughout the automotive industry as it represents the most simple and effective charging solution for electric vehicles. A strong magnetic field, generated by a car and the ground can present certain safety risks, should a person or animal enter the field.

Oxford researchers have developed an elegant safety solution that uses nuclear quadrupole resonance to detect biological material within the WPT magnetic field. The device can differentiate between human and animal tissue and can provide feedback to a kill-switch for the WPT system. This approach is affordable and more reliable than existing radar-based solutions.



FULL WEB PROFILE ▶

# HIV Vaccine

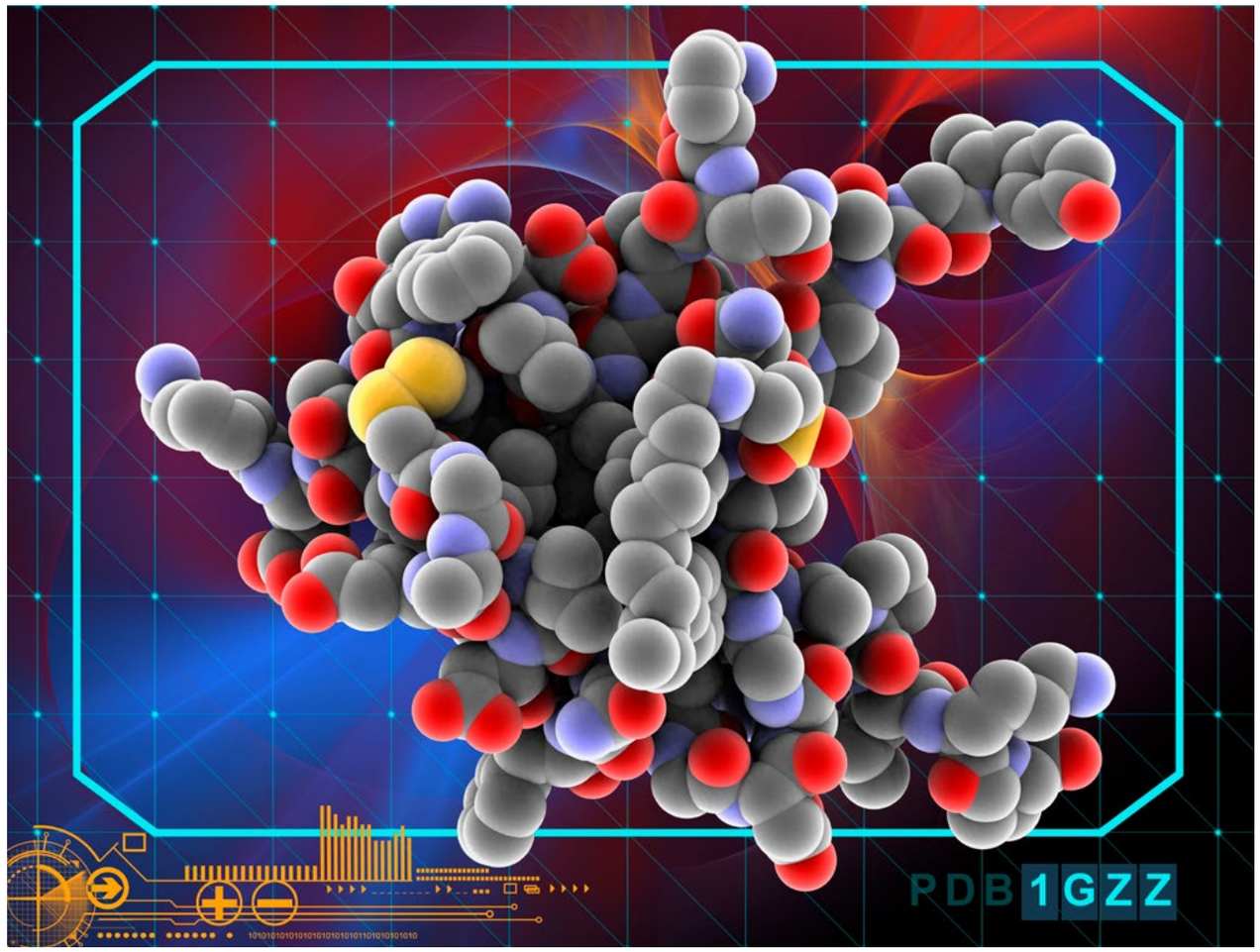


A roadblock in the development of effective treatments and vaccines for HIV is the large degree of genetic variation present between strains. Previous vaccines based on HIVconsv proteins have suffered from suboptimal coverage owing to these genetic differences.

Oxford researchers have expanded on the HIVconsv methodology, developing a series of chimaeric immunogenic proteins, tHIVconsvX (X = 1-6), which offer far greater coverage. Consisting of several highly conserved regions of the HIV proteome the polypeptides are combined in a manner that reduces irrelevant, anti-junctional immune responses, thus increasing the efficiency and coverage of the cytotoxic T-Cell (CTL) response.

FULL WEB PROFILE ▶

# Analysing insulin-like growth factors in cancer




Insulin-like growth factors (IGF) are overexpressed in cancer cells and reductions in their expression are associated with tumour reduction. Previous efforts to inhibit IGF signalling by focussing on the IGF1 receptor have so far been unsuccessful.

Researchers at the University of Oxford have investigated the IGF2 receptor (IGF2R) and have identified mutations in domain 11 of IGF2R that increase the affinity of IGF2 to its receptor. These mutated receptors have been shown to treat hypoglycaemia and reduce tumour volume.

FULL WEB PROFILE ▶

# Netmob 2019

The availability of mobile phone datasets has opened the possibility to improve our understanding of how humans communicate, socialise, move around cities and mobilize. Netmob, a conference on the scientific analysis of mobile phone datasets, will take place on 8-10 July 2019 at the Mathematical Institute in Oxford.

Netmob will focus on social, urban, societal and industrial applications of mobile phone data. Methodologically, researchers will investigate new ways to extract information and to model human behaviour, within the fields of Data Mining, Topological Data Analysis, Network Science, Mobility Modelling and Inference. Particular attention will be given to call data records, but the conference will also focus on data collected through mobile Apps. Dedicated tracks will explore essential issues like privacy and the potential use of mobile data for the common good.

In preparation for this conference, OUI Consulting Services are providing marketing support and will be on hand to support academics, sponsors and attendees for any commercial ideas that might evolve from the event.

FURTHER INFORMATION ▶

# Making AI accessible

**For Oxford University students interested in artificial intelligence (AI), learning about AI and machine learning isn't limited to technical training in their field. The Oxford Artificial Intelligence Society (OxAI), a student-led organisation, aims to shape the Oxford community and the future of technology by providing a platform for educating, connecting and inspiring people interested in AI. The team driving this initiative believes that development and creativity in AI require an interdisciplinary community to reach their full potential and builds this through hosting events across Oxford.**

To achieve its goals, the Society hosts educational events such as technical workshops, study groups and lectures to teach basic coding competency and advanced machine learning techniques. Members may apply their skills to existing research or projects such as those carried out by OxAI Labs, and new ideas and collaborations arise from OxAI's social gatherings. For students seeking employment, the Society hosts career events that connect students with external opportunities in the public and private sector. OUI Consulting Services helps ensure that students receive the support they need to lead the future of AI.

Ultimately the true value of the society lies in the diversity and expertise of its members who shape AI development and its global impact.

FURTHER INFORMATION ▶

# The future of healthcare


**In September, Massachusetts Institute of Technology (MIT) Industrial Liaison Program joined Oxford University to host an event dedicated to healthcare technologies of the future. The first half of the day was led by brief introductions from Sheryl Greenberg, MIT Corporate Relations/Industrial Liaison Program and Paul Ashley, Head of Licensing and Ventures - Life Sciences, Oxford University Innovation. Lord Paul Drayson, CEO of Sensyne Health, later shared his views on new research methods that could help clinicians and researchers shape the future of the NHS.**

Academics from Oxford and MIT describe new approaches to improve healthcare delivery and the patient experience, while startup founders from both institutions presented ventures innovating in diverse fields ranging from drug discovery to gene therapy.

The Oxford Innovation Society meeting and dinner rounded off the evening with further talks sharing experiences if cluster development at MIT and Oxford.

FURTHER INFORMATION ABOUT THE OIS ▶

# Celebrating Oxford new startups

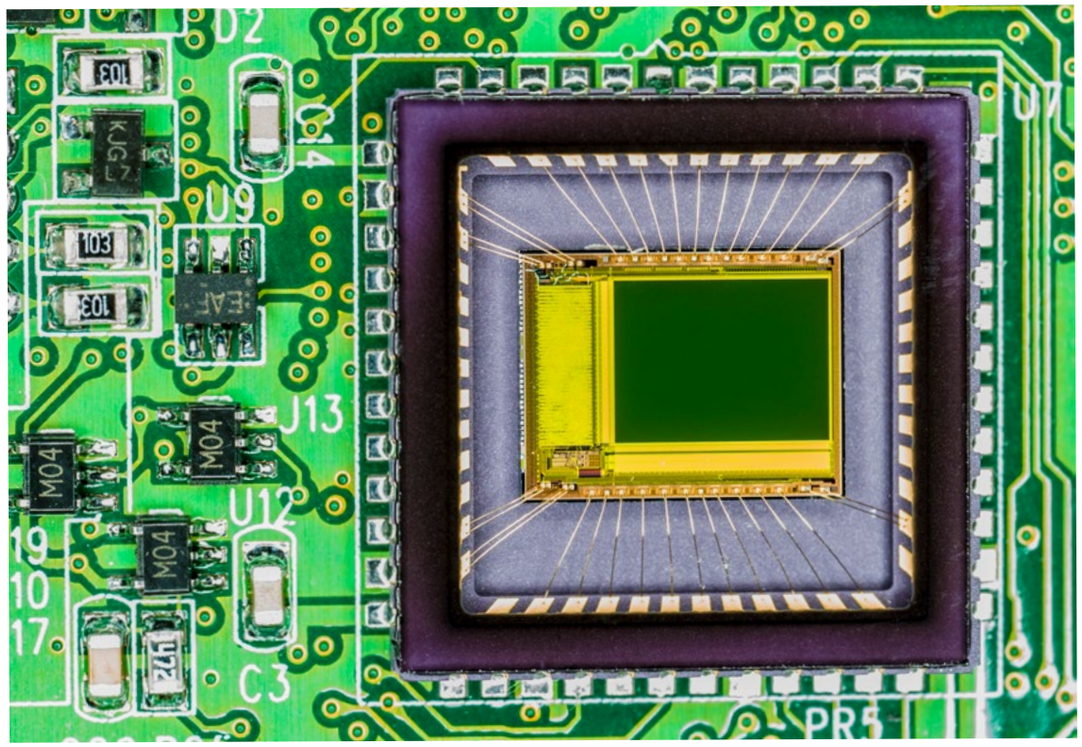

The #StartedinOxford demo night returned to Oxford Weston Library on 8th November for its 4th year. 19 Oxfordshire-based startups were given the opportunity to showcase their ideas and products to a wide range of people from Oxfordshire's entrepreneurial community. Intelligent data converting software, an innovative prevention led healthcare system, a creative thinking training tool, and a social enterprise working space aimed at students with mental health were few of the notable startups on the night.

The venue quickly filled with over 300 attendees who were encouraged to invest their 1000 #StartedInOxford dollars in the startups of their choice. The startup with the most investment at the end of the evening received a prize. The winner was Common Ground, a social enterprise that supports student mental health and engages with the community.

FURTHER INFORMATION ▶

# Novel pixel design to maximise fill factor

**CMOS (Complementary metal oxide semiconductor) image sensor technology is widely used in several applications such as digital cameras, video cameras, and smartphones. In recent years, CMOS image sensors have dramatically improved their performance but there is a constant demand for further improvements to sensor sensitivity.**




Researchers at the University of Oxford have found a novel pixel design technique that maximises the fill factor whilst obtaining high sensitivity. The researchers removed the constraints of squared-shaped pixels and optimised the fill factor of the entire pixel matrix.

FULL WEB PROFILE ▶

# The Oxford spinout company using AI to diagnose heart disease

ULTROMICS

**Save lives and save money for the health service. It's an outcome few could complain about, and it's happening because of artificial intelligence (AI).**

The medical diagnostics company behind this development, Ultromics, was spun out from Oxford University research around 18 months ago. Using the power of AI, Ultromics aims to improve the accuracy of echocardiogram interpretation to above 90% – substantially better than the 80% currently achieved by human doctors.

This, say the company's founders, will save lives by identifying more people at risk of heart disease and – by reducing the number of patients unnecessarily sent to theatre – potentially save billions for health services around the world.

CONTINUED ▶

**“ … you need an expert to interpret the images and reach a diagnosis. When the expert is good, then the test can be very accurate. But because levels of experience vary, this can be difficult to control. ”**

Paul Leeson, Professor of Cardiovascular Medicine

Paul Leeson is Professor of Cardiovascular Medicine in Oxford's Radcliffe Department of Medicine and one of the founders of Ultromics. He says: ‘Echocardiography is the most widely used imaging test in people with heart disease. In most hospitals, over ten times more echocardiograms are performed than any other imaging test in cardiology. This is because echocardiograms can be performed quickly, anywhere in the hospital, including at the bedside or in the clinic. Echocardiograms are also performed in the community and in remote locations, or areas where resources are limited.

‘However, you need an expert to interpret the images and reach a diagnosis. When the expert is good, then the test can be very accurate. But because levels of experience vary, this can be difficult to control.

‘We wanted to fix this by using AI methods to standardise how images are analysed, lifting the quality of interpretation so that it is always as good, or better, than an expert reader. To do this, we built up databases of hundreds of thousands of echocardiography images linked to information about what was unique about the person who was being imaged and what happened to them over time. By combining machine learning with clinical know-how, we were able to identify associations between features hidden within the echocardiography images and what happens to patients. Doctors can then use this information to decide how to look after the patient.

CONTINUED ▶

# INNOVATION insights

## FEATURED ARTICLE

'Ultromics' co-founder and CEO Ross Upton is, perhaps unusually in a University spinout company, a current graduate student at Oxford, nearing completion of his DPhil in cardiovascular medicine under Professor Leeson. Upton had the idea of applying AI and machine learning techniques to this field after learning of the shortfall in the accuracy of diagnosis. Within two years, Ultromics had been spun out of the University with the help of Oxford University Innovation attracting more than £10m in investment led by Oxford Sciences Innovation.

Upton says: 'The first product of Ultromics, EchoGo, is based on extracting features from stress echo images and using a supervised machine learning model to predict the outcome of a patient one year following the test. The features we extract from the images are all biologically relevant to the disease process – some of which are clinically known and others which are entirely novel features that we have patented.

**“By using the AI technology to ensure consistent and accurate interpretation, you can reduce the need for unnecessary additional investigations and ensure you do not miss disease. This improves the care of the patient and significantly reduces costs for the NHS.”**

Paul Leeson, Professor of Cardiovascular Medicine

'We used one-year patient outcomes as the gold standard, rather than how someone has reported the scan, because we know operators interpret the scan correctly only 80% of the time. We therefore need to follow up the research participants for a year after the exam to see what actually happened to them after the test. If the test is interpreted incorrectly, the patient would get sent for an angiogram unnecessarily; if the test was reported as normal but there was underlying disease, then the patient would get sent home when they should have been sent for an angiogram. It's these errors that EchoGo is going to reduce. '

CONTINUED ▶

Professor Leeson adds: 'Stress echocardiography is used widely across the world – it is the most commonly used functional imaging test for coronary artery disease in the UK. By using the AI technology to ensure consistent and accurate interpretation, you can reduce the need for unnecessary additional investigations and ensure you do not miss disease. This improves the care of the patient and significantly reduces costs for the NHS. Also, because stress echocardiography uses ultrasound equipment that is already available in hospitals and can be delivered by existing clinical staff, it means hospitals can more carefully consider whether they need to spend money on expensive new tests and infrastructure or instead put their existing infrastructure to better use.'

The next step for the company, says Upton, is to achieve a CE mark and clearance from the US Food and Drug Administration – hopefully by the spring of next year, so that EchoGo can be introduced to clinics and begin improving patient outcomes. He adds: 'We are also looking to expand our already large-scale clinical trial to 30 different hospitals across the NHS. The next innovation is to completely automate EchoGo, which will help provide an instantaneous result to clinicians. This will be done by utilising newer deep learning frameworks, which are being refined at the moment by our research and development team. Following that, we will look to tackle other disease areas within echocardiography, such as heart failure and valve disease.'

CONTINUED ▶

Reflecting on the process of spinning out a commercial company from University research, Professor Leeson says: 'A lot of companies are spun out from Oxford, but that is not because it is an easy thing to do. The number reflects the amount of high-quality, truly "translatable" research being carried out by investigators in departments. This is coupled with very effective and experienced support from Oxford University Innovation. From concept to spinout took us two years, and we had to get over a range of hurdles on the way, including securing IP and patents, being awarded pre-spinout seed funding to build aspects of the technology that would be attractive to investors, and, finally, convincing a lead investor to invest in both the technology and us, as founders.

'You have to have a really game-changing idea, with science to back it up, to convince investors. Even at that stage, negotiating the details of how the company is formed and its ongoing relationship with the University can take several months to arrange.
After that, the Oxford environment, with supportive backers such as Oxford Sciences Innovation, means the acceleration and growth of the company can be very rapid.'

FURTHER INFORMATION ON AI ▶ FURTHER INFORMATION ON ULTROMICS ▶

Enterprising Oxford
Supporting Entrepreneurial Connectivity

UNIVERSITY OF OXFORD

# Want to be part of entrepreneurial Oxfordshire?

Enterprising Oxford, a University of Oxford initiative, is an online map and guide to entrepreneurial opportunities, resources, events, spaces and people in Oxfordshire.

Get involved at:

**eship.ox.ac.uk** **@enterprisingox** **Enterprising Oxford**

# INNOVATION insights


## OXFORD INNOVATION SOCIETY 2019

The Oxford Innovation Society (OIS) is an open innovation network for industry, academia, and investors. The next meeting will be held on:

- Thursday 21 March

Meetings are held in Oxford for OIS members and invited guests, and are followed by a formal reception and dinner.

Details on www.innovation.ox.ac.uk/ois

# INNOVATION insights Survey


## Let's be honest...

**...two years and 10 issues after our last refresh, Innovation Insights continues to promote new technologies, investment opportunities and consultancy engagements.**

Now we would like to hear from you.

We have created a short anonymous survey and would like to hear your views on how Innovation Insights is working.

Please spare a few minutes to let us know what you think about our termly newsletter.

The survey should only take a few minutes to complete.

**TAKE ME TO THE SURVEY ▶**

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