YOUR SG GUIDE TO
RESEARCH, INNOVATION AND ENTERPRISE

RIE NEWS

Photo: Lucence Diagnostics

TECH-TO-MARKET
Digital technologies leap from research labs into markets

INTERVIEW
Dr Tan Min-Han talks about his startup in liquid biopsy

SCIENCE
Building zinc oxide nanopillars to kill germs

FEATURE
Overcoming antimicrobial drug resistance

TRENDING

RESEARCH NEWS

New fellowship for artificial intelligence opens for application

Researchers keen to lead ground-breaking research in AI or AI-related fields have the opportunity to do so now in Singapore.

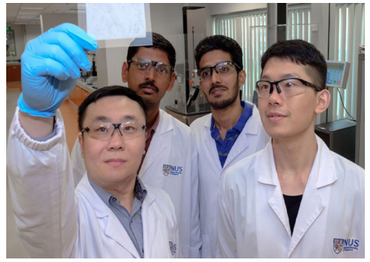
NRF has just launched a Fellowship for AI to attract outstanding young researchers from around the world to lead impactful and independent AI research in Singapore. The Fellowship offers a five-year research grant of up to S$3 million. Details at www.nrf.gov.sg.

SWITCH on and up!

SWITCH is gearing up to be a hot gathering of all the best tech events in one place from 17 to 20 September at the Marina Bay Sands. Highlights include a startup pitching competition to help tech entrepeneurs gain access to funding and a global women-in-tech movement that celebrates female innovators. Head to social media channels @SWITCHSingapore for details.

Hydrogel the solution to less humid days

Feeling warm and sticky in our humid weather? NUS has developed a new product that extracts water molecules from surrounding air directly. This can reduce relative humidity in a confined space from 80% to 60% in less than 7 minutes.



Company investing in R&D through corporate laboratory in university

Agribusiness company Wilmar has partnered NUS to set up a research lab to conduct research into clinical nutrition. Some research areas include healthier cooking oils that can reduce cholesterol levels, and food products that can help people manage diabetes and obesity.

The lab will also tap on synthetic biology techniques to engineer microbes and enzymes to produce biochemicals. These biochemicals can be used in food, fragrances, and therapeutics.

SENTIMENT ANALYSIS PROVIDES COMPANIES WITH VALUABLE CONSUMER INSIGHTS

It is quite often that we search for user comments on Facebook, Twitter and blogs to read about other people's experiences of brands and products. While at it, we may occasionally encounter expressions such as "shiok", "paiseh" and "alamak"!

But how does a company derive insights about their customers from this large treasure trove of user-generated comments?

A*STAR may have the answer to this. Its research team at the Institute of High Performance Computing (IHPC) has developed SentiMo, a linguistic-rule based system that determines the sentiment present in a message. The technology automatically classifies a message into six sentiment categories on a spectrum from positive, mixed-positive, neutral, mixed-neutral, mixed-negative, to negative. It can also identify the degree to which emotional states such as satisfaction, happiness, excitement, sadness, anxiety and anger are expressed. SentiMo is also the first sentiment analysis tool that has incorporated a lexicon of over 400 common words and phrases in Singlish!

Using the system to analyse user-generated content, the researchers were able to help companies derive insights into brand perceptions or compare "love" and "hate" points of competing consumer products. This allows marketers to carry out targeted campaigns for different market segments or products.

Since SentiMo, IHPC has further developed a tool Crystalace, which can be used by companies to detect sarcasm from seemingly positive comments.

More at www.sentimoplus.com and www.crystalace.socialanalyticsplus.net.

SMU CREATES SAFER FACE AUTHENTICATION METHOD

Passwords become a thing of the past with safer face authentication technology

Cybersecurity is a key consideration of software developers looking to deliver effective applications that are resistant to malicious attacks.

A team of researchers at the Singapore Management University's (SMU) Secure Mobile Centre understands this and is working to improve existing face authentication methods.

Face authentication offers a convenient alternative to passwords, as users do not need to tap their memories to recall passwords. However, popular face authentication systems have an intrinsic vulnerability against media-based facial forgery, where adversaries use photos or videos of their victims' faces to circumvent face authentication systems.

"Media-based facial forgery attacks pose a severe threat to existing face authentication systems," said Associate Professor Li Yingjiu at the Secure Mobile Centre.

To address this vulnerability, Associate Professor Li and his team developed FaceLive, a technology that uses liveness detection to distinguish between legitimate face biometrics of live users and forged face biometrics.

To activate the technology, FaceLive simply requires the user to hold and move a mobile device in front of his/her face over a short distance. The front-facing camera on the device captures a video of the user's face while the inertial sensors record motion data of the device simultaneously. A live user is detected if changes in head poses in the facial video are consistent with the device movements.

"Rigorous user studies and experiments have shown that media-based facial forgeries can hardly spoof FaceLive," said Associate Professor Li.

"FaceLive is practical because it does not require any additional hardware but a generic front-facing camera, an accelerometer, and a gyroscope, which are commonly available on mobile devices," he said.

Indeed, this technology could be adopted in the near future by mobile device manufacturers looking to provide their users a secure and practical face authentication solution to unlock their devices. Other potential adopters include mobile banking, mobile payment and cloud service providers, who need to maintain a high degree of security in the services they provide.

The researchers are currently working with Singapore-based company i-Sprint Innovations to further improve the resilience of FaceLive. This includes ensuring that FaceLive is secure against 3D virtual face model attacks.

"In a 3D virtual face model based attack, an adversary builds a 3D virtual face model for a user based on the user's photos and videos, and then synthesise necessary facial movements and/or expressions using the 3D model to spoof face liveness detection," Associate Professor Li explained.

STARTUP PROGRAMME HELPS BUDDING ENTREPRENEURS BRING TECH TO MARKET

IoT365 presenting its tech solution at the Lean LaunchPad Singapore programme's cybersecurity track. Photo: NUS Enterprise

Mobile phones, smart watches, smart TVs, fitness trackers, and smart speakers have become indispensable to modern day living. Researchers have predicted that by 2020, there will be more than 24 billion internet-connected devices around the world. This translates to an average of four devices per person. As the number of these Internet of Things (IoT) devices increases, so does the complexity of ensuring the security of personal data generated and stored in them.

Research fellow Van-Thuan Pham from the National University of Singapore's School of Computing and his team from local startup IoT365 are working on an automated fuzzing-based testing technology to find bugs and vulnerabilities in IoT devices. He hopes that with their technology, consumers, companies and government agencies can use IoT devices with a greater peace of mind.

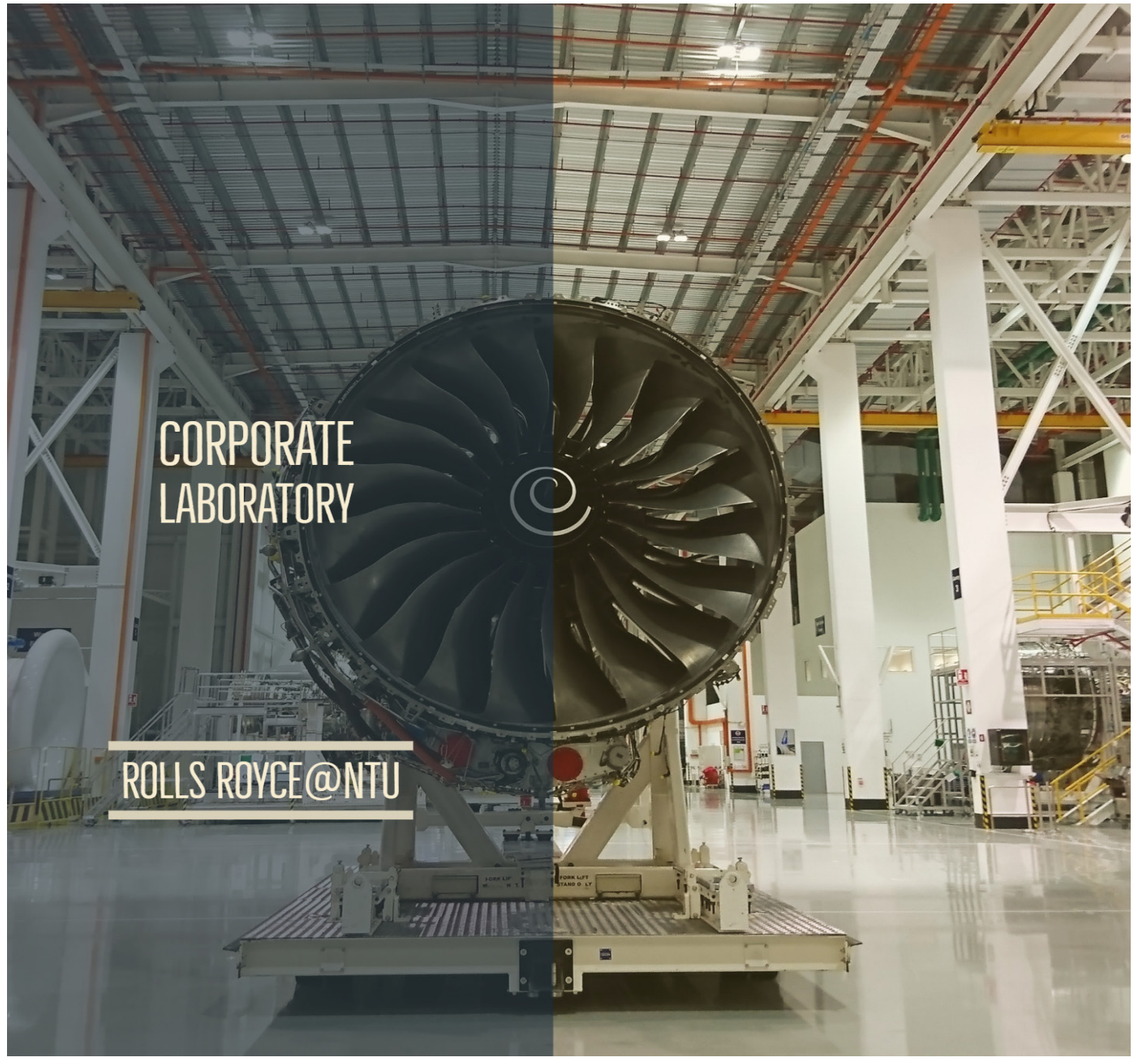
Pham said that IoT devices are particularly vulnerable to attacks due to differing communication protocols used in different devices, and the lack of security standards to ensure compliance. "Much of the current testing of IoT devices is manual and ad-hoc, which can leave security loopholes for malicious hackers," he added.

As a participant of the cybersecurity track of the Lean LaunchPad Singapore programme that was held from April to June, Pham and his team received advice from industry practitioners and investors on how they should first work with a team of white-hat hackers or collaborate with a well-known security testing company, before commercialising their product. Through the programme, they met over 30 potential customers including product manufacturers, system integrators, government agencies and consulting firms.

Local startup Scantist is another participant of the programme. Scantist offers software composition analysis to detect vulnerabilities and bugs in different platforms and applications. It uncovers vulnerabilities from the onset at the software development stage, which means reduced cyber risks and a faster process for a software to be marketed. Their end-to-end service also offers remediation reports that highlights codes that need to be fixed and suggestions on how fix them.

Scantist was awarded a grant under the National Cybersecurity R&D Programme's second grant call last year, and currently has a beta product that is offered for trials. Through the Lean LaunchPad Singapore programme, Scantist met a large multinational company who will work with them to conduct further testing and design refinement for market needs. They are now running field trials for evaluation with Fortune500 companies, government agencies as well as smaller startups, and the first commercial product will be released in the next few months.

Organised by NUS Enterprise and supported by NRF, the Lean LaunchPad programme helps early tech startups and publicly-funded research teams learn about technology commercialisation. Participants are mentored by industry practitioners, investors and entrepreneurship educators on how to validate the commercial potential of their innovations, pinpoint target customer segments and understand product development requirements.



INDUSTRY-ACADEMIA COLLABORATION

THE RIGHT FORMULA FOR ROLLS-ROYCE

What do Boeing and Airbus aircraft have in common?

They are both powered by engines produced by Rolls-Royce, a British company that has its origins dating back to over a century ago.

Rolls-Royce started its footprint in Singapore in the 1950s. In 2012, it opened its 154,000 square metre Rolls-Royce Seletar Campus, a state-of-the-art manufacturing, assembly, test, training and research facility.

The facility produces Trent 900 engines for the Airbus A380, Trent 1000 engines for the Boeing 787 Dreamliner, and Trent 7000 engines for the new Airbus A330neo aircraft. It also produces wide chord fan blades for the Trent 900, Trent 1000 and the Trent XWB engine, which powers the Airbus A350.

More recently in 2013, Rolls-Royce invested in a Corporate Laboratory in Singapore, setting the stage for the birth of new technologies that can transform the aerospace industry.

"Our operations in Singapore create an opportunity for the development of a strong aerospace supply chain as we look to the region to play a bigger role in our global supply chain," said Dr Bicky Bhangu, Rolls-Royce President of South East Asia, Pacific & South Korea.

Collaboration with Researchers on Breakthrough Technologies

Rolls-Royce sees the value in collaborating with research institutions here. The Corporate Laboratory was set up in partnership with Nanyang Technological University (NTU), and is the first of its kind in the world.

"The goal of the Rolls-Royce@NTU Corporate Laboratory is to resolve technological challenges by combining Rolls-Royce's industrial expertise and business capabilities together with NTU's research and academic skills. It focuses on three main areas: electrical and control systems, data analytics and

complex systems, and manufacturing and repair technology," said Dr Bhangu.

Research projects are launched at the Corporate Laboratory when a problem or area that requires novel research is identified by Rolls-Royce. These focus areas can be identified by any part of the business around the world, which means that the work carried out by the Corporate Laboratory team has a real global impact.

Once a research area has been identified and agreed, a Rolls-Royce project manager is assigned alongside a Professor from NTU who work together to hire a specially selected research team to develop the technology and complete the research objectives.

The teams work towards set project timelines and once the objectives have been met, the project is either pulled into a commercialisation process into the business or into other laboratories for higher Technology Readiness Level development.

One project that is ongoing at the laboratory is to develop advanced sensor technology for fan blade manufacturing.

"Manufacturing a fan blade is an exercise of extreme precision," said Dr Bhangu.

To fully push the potential of sensor and digital technologies, the team is using sensors to capture online process information and predict the outcome of a fan blade's edge geometry and surface quality. This will increase the productivity and quality of the fan blade manufacturing process, and reduce the risks of human error.

Dr Tegoeh Tjahjowidodo, Associate Professor at NTU's School of Mechanical & Aerospace Engineering, who works on the project, adds that through the introduction of in-process sensing technology, the skin thickness of fan blades can be deduced indirectly from "voices" in the process – either from a vibratory signal or acoustic emission signal – removing the need for offline measurement.

"This technology will reduce the total cycle time taken for each fan blades finishing process, therefore helping to increase facility productivity," he adds.

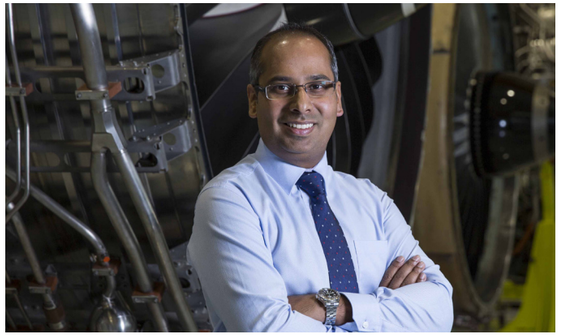
Digitalisation the way forward for industry

As one of 30 Rolls-Royce University Technology Centers around the world, the Rolls-Royce@NTU Corporate Laboratory has contributed the most significant intellectual property (IP) among all the laboratories in its network.

With over 140 researchers and 40 PhD students working in the laboratory, Rolls-Royce is actively training the next generation of talent for the aerospace ecosystem. They build a strong foundation of capability within Singapore to support the sector, which is expanding rapidly.

Reflecting on the progress made by the laboratory, Dr Bhangu said: "The Lab aims to continue to pioneer this successful collaborative model for technology development, and will continuously look for areas where we can make a significant industry or business impact."

To stay at the forefont of innovation in the sector, the focus for Rolls-Royce will be around development of



Dr Bicky Bhangu, President - South East Asia, Pacific and South Korea, Rolls-Royce. Photo: Rolls-Royce

Dr Tegoeh Tjahjowidodo, Associate Professor, NTU. Photo: Rolls-Royce

next generation propulsion platforms such as hybrid-electric solutions, as well as the development of Industry 4.0 technologies, such as smart manufacturing and artificial intelligence for improved production processes.

Last year, the company partnered A*STAR and Singapore Aero Engine Services Private Limited to set up a joint laboratory to develop smart manufacturing technologies here. It will develop manufacturing technologies, such as 3D industrial printing of aero-engine components, and advanced robotic and automatic solutions.

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"Our operations in Singapore create an opportunity for the development of a strong aerospace supply chain as we look to the region to play a bigger role in our global supply chain," said Dr Bicky Bhangu, Rolls-Royce President of South East Asia, Pacific & South Korea.

INTERVIEW

DR TAN MIN-HAN

Dr Tan Min-Han is a cancer specialist guided by a sense of mission. He wants to tap on innovation to deliver the best healthcare for cancer patients in Singapore and the region. His most recent undertaking is Lucence, a company that has developed blood tests for cancer detection.

Your work spans diverse fields of cancer genetics, diagnosis, and treatment. You also started Lucence Diagnostics, which provides cancer-detection tests using liquid biopsies. Why did you choose to specialise in cancer, out of the many medical fields?

As a junior physician some twenty years ago, I was most struck by my work with cancer patients. Over many hours and nights, I witnessed great suffering, but I also saw the ability of modern medicine to alleviate a lot of unnecessary pain and distress. Oncology exists at an interface where bedside medicine, high technology, deep research and profound spirituality coexist. Fighting cancer is undoubtedly one of the greatest challenges of modern medicine. I think solving this challenge would make my life worthwhile.

What made you first think about starting Lucence? What was the process like?

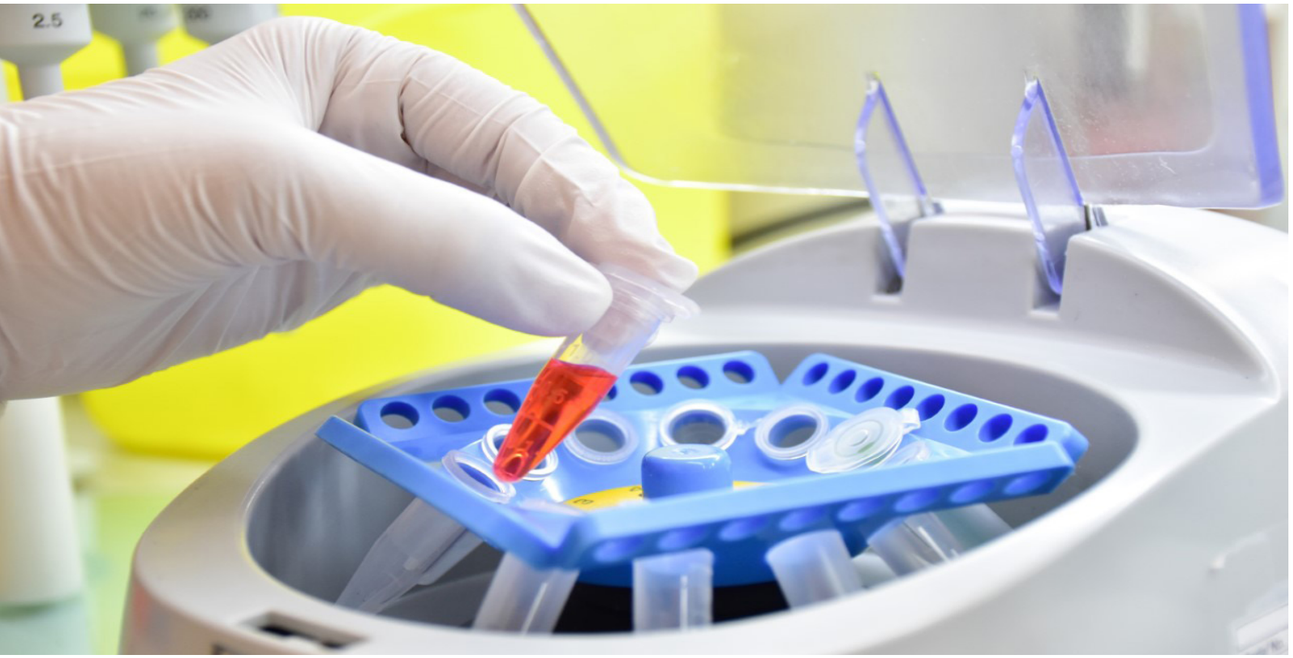
I have always believed that a medical technology company founded on deep clinical intelligence is the best way of delivering innovation to cancer patients. In the last eight years, my laboratory at A*STAR has made important discoveries and innovations in cancer genetics, and Lucence was the natural outcome of that.

Of course, the bench and the bedside should always go together - and I believe that the most important medical advances must come first from a profound understanding of patients' needs. I still see patients for genetic counselling at our genetics clinic at Gleneagles Hospital, and have weekly consultations at the National Cancer Centre Singapore and Tan Tock Seng Hospital.

I am grateful to the support of people who have helped me along the way of setting up this company - the wonderful people at A*STAR, physicians and our investors, who believed that great technology can truly improve the lives of cancer patients. Most importantly, the oncologists who have worked with us to improve the lives of their patients - we're proudest of our work done in collaboration with them. They are the ones helping patients directly on a daily basis.

You are looking to expand Lucence into new overseas markets, including Hong Kong and Silicon Valley. What are your expansion plans?

Lucence already has an office in Hong Kong and partners in ASEAN; and is planning to open an office in Silicon Valley later this year. Cancer is a worldwide threat with no national boundaries. wPatients everywhere share the same needs for better diagnostics for better treatments. Our platform technology targets the most common cancers in the world like breast, lung and colon cancers, but we recognise very real needs also in underserved cancers in Asia, such as nasopharyngeal cancer. We should understand that Asia is 60% of the world's population.



Blood sample preparation process. Photo: Lucence Diagnostics

Share with us something about your company that you are working on to improve and how that would lead to better outcomes.

We have developed the world's first blood test that can detect multiple genetic mutations and cancer-causing viruses, with a special focus on cancers in Asia. Asia is the source of 60% of the world's cancers, and research has shown that there are higher cancer death rates in Asia than most other regions. We are facing an impending cancer epidemic in Asia as the population grows and the incidence rate of cancer increases due to changes in lifestyle. Moving forward, we see our technology enabling the early detection and targeted treatment of cancer. This will improve survival rate and alleviate the suffering of patients.

What are the upcoming developments in liquid biopsy that you think would be the most significant?

Liquid biopsy has demonstrated clear value today in selecting targeted therapy for late stage cancer patients. This reduces side effects and futile treatments, but it is not enough. The validation of liquid biopsy as an early screening tool for multiple cancers will be one of the most exciting upcoming developments in cancer diagnostics. Lucence will contribute toward this by running large studies of our technology and analytics built here in Singapore.

What are your visions for liquid biopsy in the future?

Liquid biopsy represents the next major wave of diagnostics. In my view, it will be as important as the microscope to diagnostics and will be extended beyond cancer to many other diseases including infectious diseases and immunological diseases. I envision that liquid biopsy will be a leading platform for true non-invasive monitoring of health.

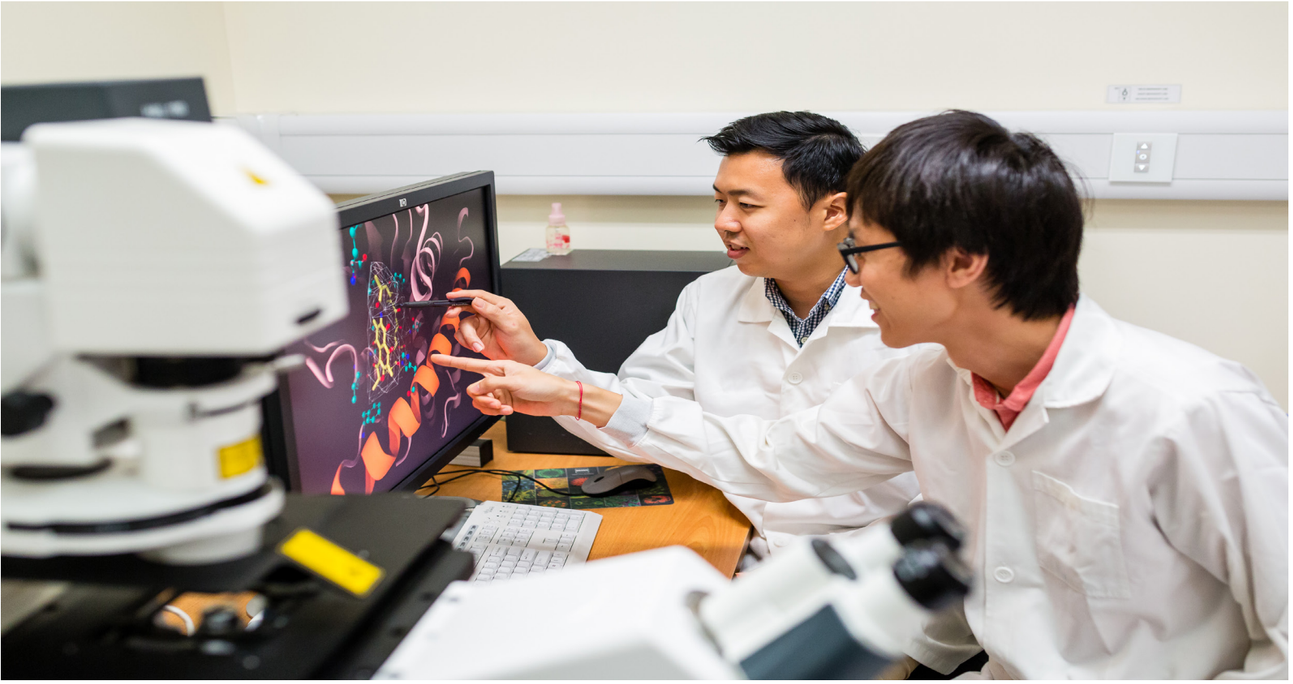
Blood collection kit. Photo: Lucence Diagnostics

You were one of the top startups at the Slingshot@SWITCH competition last year. What are your tips for startups looking to differentiate themselves from their competitors?

To differentiate your company, it is important to solve a real need with deep technology, together with a team of people who are fully committed to the mission. It is also important to be customer-focused. For example, Lucence is not alone in this war against cancer – we are here to support the dedicated and focused physicians and help them fight cancer together with their patients. So, we should always be working toward meeting the needs of our customers, which will help us to stay competitive.

SINGAPORE ACTS TO STEM BACTERIAL RESISTANCE TO ANTIBIOTICS

CHRISTOPHER C. FRASER
SCIENTIFIC DIRECTOR
ANTIMICROBIAL RESISTANCE INTERDISCIPLINARY RESEARCH GROUP
SINGAPORE-MIT ALLIANCE FOR RESEARCH AND TECHNOLOGY



Professor Peter Dedon, Lead PI, AMR Programme, MIT

Professor Peter Preiser, Co-Lead PI, AMR Programme, NTU

The growing resistance of human infections to antimicrobial drugs has emerged as one of the most pressing public health problems in Singapore and the world.

The rising tide of antimicrobial resistance (AMR) is affecting public health and the economy in Singapore, Southeast Asia and the entire world. In Singapore, up to 50% of infections acquired in hospitals are resistant to front-line antibiotic therapies. This is illustrated by high incidence of methicillin resistance in infections by Staphylococcus aureus (MRSA) in healthcare facilities in Singapore.

More sobering, however, are predictions about the impact of AMR globally in the coming decades. While AMR currently results in about 700,000 deaths per year worldwide, recent studies predict an increase to 10 million deaths per year by 2050, outpacing the mortality of cancer. The economic burden is similarly staggering. In the US alone, antibiotic resistant bacteria infect 2 million people every year at a health care cost of S$27 billion. On a global scale, AMR is predicted to cost up to S$130 trillion by 2050.

In spite of this AMR crisis, academic and industrial research and development efforts have focused on non-communicable diseases such as cancer. In the biotechnology and pharmaceutical industry in 2014, there were about 800 oncology drugs but only 50 antimicrobial agents introduced into the development pipeline. Funding for AMR research also falls short from both biotechnology and academic sources. The US National Institute of Health (NIH), for example, allocated only 1.2% of grants for AMR research in 2009-2014, whereas 18.6% was allocated for cancer research.

The NRF has stepped in to address this critical unmet need for funding research and development of new antimicrobial resistance drugs and diagnostics by launching a new SMART Antimicrobial Resistance Interdisciplinary Research Group (AMR IRG).

The AMR IRG is co-led by Professor Peter Dedon, the Underwood-Prescott Professor of Biological Engineering at MIT, and Professor Peter Preiser, Chair of the School of Biological Sciences at Nanyang Technological University (NTU).

They lead a team of 14 world-class professors from NTU, Duke-NUS, Tan Tock Seng Hospital, Singapore General Hospital, and MIT. The AMR IRG builds on strong collaborations with Singaporean scientists and clinician-scientists to integrate innovative MIT technologies into the development of new antimicrobial agents and diagnostic and surveillance tools.

AMR IRG leaders are optimistic about the impact of this joint effort to combat AMR, which builds on a decade-long track record of high-impact infectious disease research from several team members.

Professor Dedon said: "It is a privilege to work with such a talented team of Singaporean and MIT researchers in the AMR IRG. This group brings exciting new technologies to bear on solving the most challenging problems posed by antimicrobial drug resistance in Singapore and around the world."

Professor Preiser added: "I am very excited about the unique opportunity the AMR research group offers to Singaporean and MIT researchers to work together to have a lasting impact on solving the global problem of antimicrobial drug resistance."

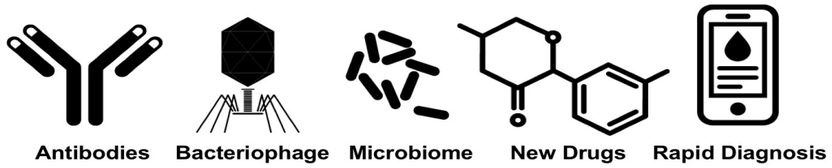
Researchers everywhere agree that the key to tackling the AMR problem is to take a multi-pronged, highly interdisciplinary approach in developing novel ways to identify, rapidly respond to, and treat drug-resistant infections.

The AMR IRG is doing just that by taking advantage of the technological, scientific and clinical strengths of MIT and Singapore, with expertise in emerging pathogens at Duke-NUS, in microbiomes and biofilms at NTU, in drug resistance and drug development at NTU and the A*STAR Experimental Therapeutics Centre, and in clinical studies at the Singapore General Hospital and Tan Tock Seng Hospital.

Research projects in the AMR IRG are approaching the threat of drug-resistant microbes from several directions. One thrust focuses on understanding the mechanisms used by bacteria, viruses and parasites to evade being killed by drugs. This is illustrated by the poorly understood behavior of some bacteria to "hunker down" and become reversibly drug-resistant when faced with stresses caused by the human immune response to the infection or when growing as "biofilms" on solid surfaces such as urinary catheters.

Defining these mechanisms is critical to developing resistance-reversing drugs. In another research thrust, AMR IRG researchers are developing rapid, sensitive and specific detection and diagnostic techniques for evaluating the spread of the resistant infections. For example, they are developing fast, cheap diagnostic tools made to be as simple as a pregnancy test and deployable in resource-limited environments.

In yet another major set of projects, AMR IRG researchers are developing new therapeutics that combat resistant infections by exploiting the human immune system and microbiome to kill AMR microbes. They are also developing new small molecule and biological drugs and drug delivery technologies to combat resistant microbes.



The collaborative efforts of the AMR IRG will also have an impact on other aspects of life in Singapore. A major emphasis in the IRG is placed on translating discoveries into clinical studies and into new companies in Singapore. These companies will not only provide critical products to combat AMR but will also employ Singaporeans.

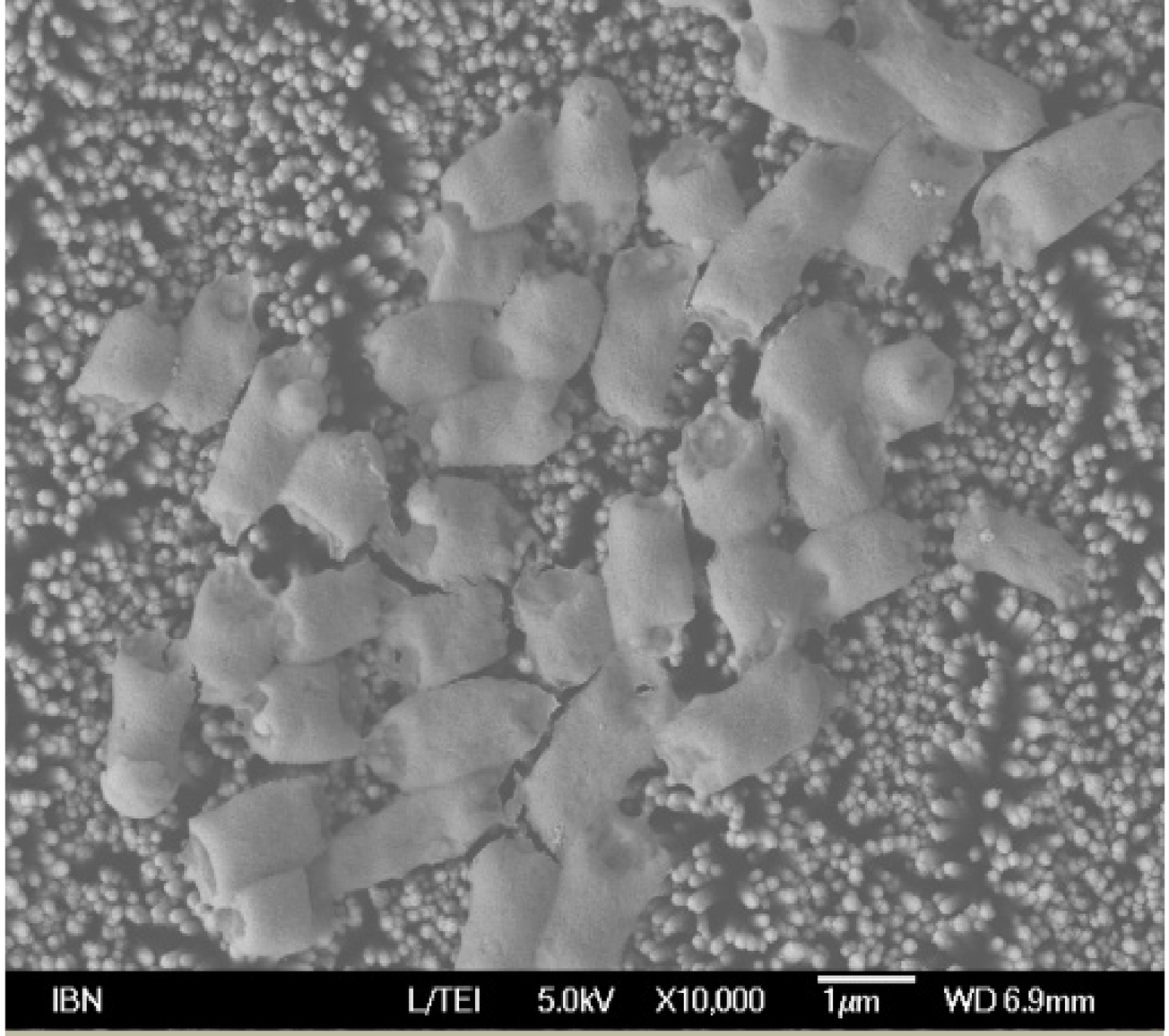
A high value is placed on the workforce training impact of the AMR IRG, with researchers jumping from the IRG to companies, agencies and universities in Singapore. The combination of innovative research and entrepreneurial spirit will have a significant impact on Singapore's growing biotechnology industry. Ultimately, the goal of the AMR IRG is to use research to enhance the health and well-being of people in Singapore and the world.

NRF announced the launch of an Antimicrobial Resistance Interdisciplinary Research Group (AMR IRG) in December 2017. Administered by the Singapore-MIT Alliance for Research and Technology (SMART), the AMR IRG works to define the mechanisms used by bacteria, parasites and viruses to resist antimicrobial drugs and use this knowledge to develop new resistance-busting therapeutics and new tools to rapidly diagnose AMR.

"Ultimately, the goal of the AMR IRG is to use research to enhance the health and well-being of people in Singapore and the world."

FEATURE

LESSON FROM NATURE



E. coli bacteria destroyed by the anti-bacterial coating made from zinc oxide nanopillars. Photo: A*STAR

The wings of dragonflies and cicadas look like very thin and fragile sheets of glass, but they are fatal to bacteria. Any bacteria that come into contact with the wings get ripped apart immediately and killed, thanks to nanopillars that look like a bed of tiny nails covering the surface.

This bacteria-killing mechanism inspired Dr Zhang Yugen from the A*STAR's Institute of Bioengineering and Nanotechnology to create a material that mimics the insect wing structure to kill bacteria without using chemicals.

The material is made from nanopillars of zinc oxide, a compound that is known for its anti-bacterial and non-toxic purposes. Zinc oxide nanopillars can kill a broad range of germs like E. coli and S. aureus that are commonly transmitted from surface contact. Laboratory tests have shown that the nano-coating effectively killed up to 99.9% of germs found on ceramic, glass, titanium and zinc surfaces.

"Our material can be used as an anti-bacterial coating on frequently-touched surfaces, such as school desks, clinic counters, medical equipment and hospital beds, to prevent contamination and the spread of infectious diseases. Studies have shown that 80% of common infections are spread by hands through contact with such surfaces, and we hope to minimise this by inhibiting bacterial growth through our coating," said Dr Zhang.

"We are trying to kill disease-causing bacteria without using harmful chemicals or antibiotics. We hope that our research will contribute toward the fight against superbugs and other healthcare-associated pathogens, to improve our quality of life," said Dr Zhang.

The use of zinc oxide to kill bacteria mechanically also reduces the use of harsh chemicals that are commonly used in anti-bacterial cleaning agents, which can cause environmental pollution and damage. Bacteria are completely destroyed when their cell walls are pierced by the zinc oxide nanopillars, which means they do not develop resistance and exacerbate the global problem of antibiotic resistance and superbugs.

Looking ahead, Dr Zhang is working on commercialising this technology through a spin-off company. His team has received a grant from NRF's Competitive Research Programme to further improve the nano-coating in collaboration with Tan Tock Seng Hospital.

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