JULY 2021

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RIE NEWS

SG GUIDE TO TECHNOLOGY, INNOVATION & ENTERPRISE

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ENHANCING HEALTHCARE THROUGH SCIENCE & TECH

Research initiatives and innovations that will transform Singapore's health system to deliver better health and healthcare outcomes for everyone throughout the years.

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Images: NTU, SUTD

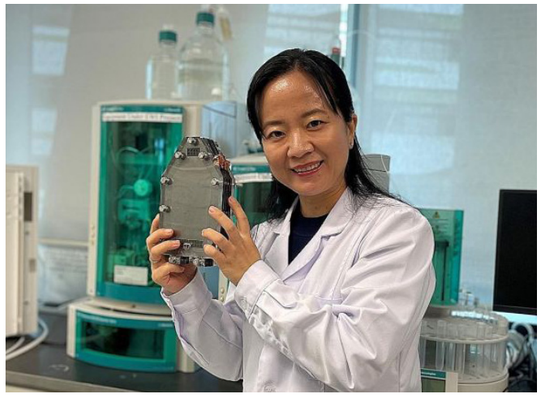
RESEARCH ROUNDUP

SOY MUCH POTENTIAL

Researchers from Nanyang Technological University (NTU) and Republic Polytechnic (RP) are working on different projects that maximise the potential of okara, or soya pulp, which is high in fibre and protein. By fermenting the okara, NTU scientists were able to produce a liquid extract that contains plant growth hormones that can spur animal cells to grow and multiply into tissue, to form cell-cultured meat. Cell-cultured protein allows meat products to be manufactured without slaughtering animals. In the same vein, researchers at RP have created a cheaper feed for abalone by using okara. Although soya pulp is used as food for livestock, the team believes their protein-rich pellets is the first abalone feed that uses okara, which also costs 30 per cent less than commercial feed.

CREATE ENERGY WHILE REMOVING SALT

A team from the Singapore University of Technology and Design (SUTD) is coupling water and energy issues to develop sustainable water management strategies. Desalination processes are energy intensive and to reduce overall energy requirements, the SUTD team is working on a new technology known as 'desalination batteries'. By placing special electrodes that can undergo chemical reactions with salt ions in seawater, the sodium and chloride ions are removed. This decreases the amount of salt in the water while simultaneously storing energy, making it act as a battery. The desalinators, which require little infrastructure to set up, can then be placed around Singapore as a distributed water network system - storing energy that powers our electricity demands.



REDUCING PAIN FROM CHEMOTHERAPY

Cancer patients often suffer from chemotherapy-induced peripheral neuropathy (CIPN), a side effect caused by a drug called taxane which causes progressive and often irreversible pain or sensitivity in the hands and feet. Cooling of the limbs during chemotherapy, or cryotherapy, has shown to be effective in preventing or reducing the severity of CIPN. To aid in this effort, a joint research team comprising of scientists at the National University Cancer Institute, Singapore (NCIS) at the National University Hospital and the N.1 Institute for Health at the National University of Singapore (NUS), have partnered Paxman, a British medical technology company, to develop a new device that could alleviate the pains of CIPN. By wrapping the device around the arms and legs of cancer patients during chemotherapy, the device helps to significantly cool the limbs, thus improving patient comfort.

Scientists from NTU have developed a reusable mask that is able to kill bacteria droplets within 45 seconds. It can also filter 99.9 per cent of bacteria, viruses and haze particles, a better performance than the medical-grade N95 masks which filter out 95 per cent. The filter of the mask is coated with a layer of copper oxide nanoparticles, which damage the DNA of important cell structures in the bacteria, causing them to die. The NTU team tested their nanoparticle coating by washing it in soap water at 45 deg Celsius for 120 washing cycles, and found that there was almost no copper loss, which means that there is little risk of toxicity to humans. There is also no contact with the human skin as the nanoparticles are bonded within the fibres of the mask. The team is looking to work with industry partners who are keen to license and scale up the production of their mask.

MASK THAT KILLS BACTERIA IN 45 SECONDS

BODY AS A MEDIUM TO TRANSMIT POWER

A NUS research team has developed a technology that enables a single device, such as a mobile phone placed in the pocket, to wirelessly power other wearable devices on a user's body, all by using the human body as a medium for power transmission. The user just needs to place the transmitter on a single power source, such as the smart watch on a user's wrist, while multiple receivers can be placed anywhere on the person's body. The system then harnesses energy from the source to power other wearables on the user's body. Hence, the user will only need to charge one device, and the rest of the gadgets that are worn can simultaneously be powered up from that single source. Experiments showed that this technology allows for a single power source that is fully charged, to power up to 10 wearable devices on the body, for a duration of over 10 hours.

A new Infectious Diseases Labs at the Agency for Science, Technology and Research (A*STAR) has been set up to coordinate disease-specific research efforts by the agency's various groups. The lab will look into the identification of an emerging pathogen through a combination of approaches – such as genetic sequencing, novel-detection assays, bioinformatics and modelling. Working closely with National Centre for Infectious Diseases (NCID), National University Health System, SingHealth, as well as international collaborators, the lab will accelerate the translation of research prototypes into clinical testing and eventual commercialisation. It will also conduct clinical surveillance to monitor for emerging pathogens that can cause infectious diseases and a pandemic. This will support the national research programme for epidemic preparedness and response.

Images: A*STAR, NTU, NUS

NEW INFECTIOUS DISEASES LABS

FEATURE

BREAKING DOWN PLASTIC POLLUTION

A*STAR scientists are tackling plastic waste with innovations in biodegradable plastics and alternatives. **Dr Li Zibiao** explains how his research could make this a reality.

The upsurge in plastic waste globally is an alarming and imperative issue. Scientists at the Agency for Science, Technology and Research (A*STAR) are tackling this challenge by developing futuristic biodegradable plastics.

Most plastics are produced from fossil fuels, known as petroleum-based polymers. These plastics are non-biodegradable, non-compostable, and often take up to 1,000 years to degrade naturally. They are filling landfills and pervading oceans at a concerning rate, posing a threat to wildlife ecosystems.

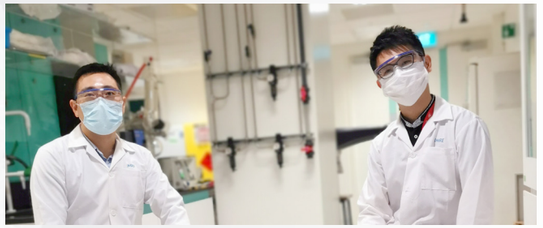
While polylactic acid (PLA) is used to make sustainable plastics that degrade within days into carbon dioxide and water under controlled conditions, they tend to be brittle, limiting their applications.

Enter Dr Li Zibiao, Senior Scientist and Head of the Advanced Sustainable Materials Department at A*STAR's Institute of Materials Research and Engineering (IMRE).

Images: A*STAR

Dr Li and his team created a PLA material that is highly pliable while remaining strong, significantly expanding its potential use. His work was first published in the Advanced Functional Materials science journal in June 2020, which was the first report of a fully bendable, malleable and toughened PLA green composite.

The team developed a bio-based filler with a rigid-elastic feature, with polyhydroxybutyrate (PHB) as the rigid segment and caprolactone D-lactide as the soft segment.

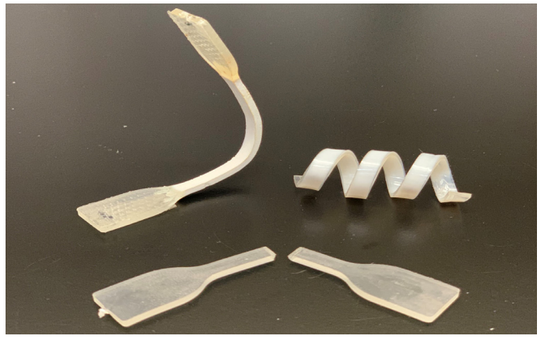


(L-R) Team lead Dr Li Zibiao and senior specialist Jayven Yeo.

"Our inspiration came from natural systems that possess both well-balanced strength and toughness – systems that have a soft structure with variable stiffness, like an octopus arm or an elephant trunk," he said.

"The bendability and malleability of our material at room temperature opens up new opportunities for green electronics."

Another potential solution to the plastic plague could be found in lignin, an organic compound found in plants, says Professor Loh Xian Jun, Executive Director of IMRE and A*STAR's Urban and Green Technology Horizontal Technology Programme Office. Lignin is a by-product of the paper pulping industry. It is biodegradable, anti-oxidative, and offers ultraviolet protection. But 95 per cent of lignin produced, up to millions of tonnes, is discarded annually.



Dr Li's prototypes (top row) compared with existing PLA materials, which are brittle (bottom row).

Now, Prof Loh and his team have technologies to process this biomass into functional materials.

Prof Loh and his team are designing biodegradable lignin microbeads to replace pollutive plastic ones in personal care products. For instance, the team collaborated with a company to co-develop a lignin-based biodegradable surfactant for detergents and dishwashers.

The team is also exploring lignin's applications in medicine. "Lignin is an excellent antioxidant, so it could be used as a biomaterial to neutralise free radicals, such as in osteoarthritis therapy or other anti-inflammation treatment," he explained.

Prof Loh's team overcame many challenges, including making lignin stable in formulations, and turning it into microbeads when it lacks internal linkages to form 3D freestanding structures. "We hope lignin will open up new possibilities for sustainable personal care products."

FEATURE

UNLOCKING THE MYSTERIES OF BLOOD VESSELS

Studying blood vessels is crucial to understanding many diseases and improving healthcare, shares **Assistant Professor Christine Cheung** from the Lee Kong Chian School of Medicine at NTU.

Even after people recover from the COVID-19 coronavirus, a lingering immune response in their blood vessels may cause them to have a higher risk of serious complications caused by blood clots, such as heart attacks and strokes.

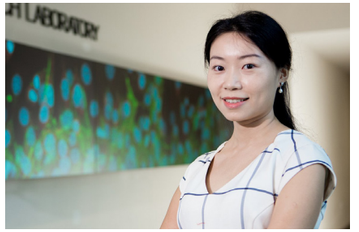
This was a recent finding by researchers at the Molecular and Vascular Medicine Laboratory in Nanyang Technological University's Lee Kong Chian School of Medicine.

"Our work suggests that Covid-19 patients, especially those with underlying chronic conditions, may benefit from close post-recovery monitoring," said Nanyang Assistant Professor Christine Cheung, who leads the laboratory, and is also the NTU Provost's Chair in Medicine.

For years, Prof Cheung and her team have studied diseases linked to changes in blood vessels, with the goal of advancing healthcare. They have also taken blood, skin and other types of cells from people, turned them back into stem cells, and developed protocols to coax them into forming blood vessel endothelial and smooth muscle cells – the major components that make up blood vessels' wall and lining.

Images: Lee Kong Chian School of Medicine

> **"...if we can identify the changes linked to vascular dementia, we have a window of opportunity to intervene, restore the blood vessels' health, and stop the disease.**
>
> Nanyang Asst Prof Christine Cheung
> NTU Provost's Chair in Medicine



"By recreating models of patients' own blood vessels, we can capture and study disease-related genetics in the vessels. These blood vessel models would contain the patients' own complex genetics and the impact of prominent environmental stressors and age-related effects, something that would not be possible with animal models," she explained.

To speed up the laboratory's research, Prof Cheung also invented an innovative way to grow these blood vessels more quickly.

"We found that there are these blood vessel progenitors in human blood that have stem cell-like qualities. By getting blood from clinics and putting it into a petri dish with media that encourages the growth of only these progenitors, we can get the latter to mature into blood vessel endothelial and smooth muscle cells in just three weeks, compared to months when we had to take cells, convert them back into stem cells, and wait for them to develop."

With this method, Prof Cheung's laboratory has shed light on some unexpected biological links, such as why people with non-alcoholic fatty liver disease tend to suffer and die from cardiovascular complications.

"We found that the blood vessels in such people produce proteins called chemokines at a heightened level. These chemokines attract more immune cells to the blood vessels' walls, and the immune cells may make inflammatory proteins that damage the blood vessels' lining. This damage can in part contribute to cardiovascular problems."

The laboratory is currently delving into many lines of research, including how changes in blood vessels lead to vascular dementia. "We want to find out what alterations occur even before patients exhibit behavioural changes and cognitive impairment."

Prof Cheung and her team are working with clinical collaborators to gather patient cohorts for this study, as they have done for most of their research. "Blood vessels are very responsive and change early on, so if we can identify the changes linked to vascular dementia, we have a window of opportunity to intervene, restore the blood vessels' health, and stop the disease."

"Studying blood vessels is truly amazing," she marvelled. "Blood vessels transcend all organ systems and underlie the crux of many health conditions. It gives you all of the necessary puzzle pieces to assemble and study in the laboratory to better understand diseases and improve healthcare."

SPECIAL

ENHANCING HEALTHCARE THROUGH SCIENCE & TECH

Singapore's **Research, Innovation and Enterprise (RIE)** investments have helped transform its health system to deliver better health and healthcare outcomes for Singaporeans throughout the years.

In particular, the **Human Health and Potential (HHP)** domain under the RIE 2025 plan, builds on the existing health and biomedical sciences capabilities and incorporates a new emphasis on furthering human potential.

The key focus in this new emphasis is to build on our existing research strengths in **prenatal and early childhood development**, and to identify, pilot and evaluate evidence-based interventions that may improve long-term health and learning capacity.

In this special segment, we will explore some of the projects under the HHP domain that will make Singapore a leading hub that **transforms and protects health**, **advances human potential**, and **creates economic value** through excellence in research and its application for Singapore, Asia and beyond.

PRIME TIME FOR PRECISION MEDICINE

The Precision Health Research, Singapore (PRECISE) is a new national body established to further research insights, improve patient outcomes and create new economic opportunities for the biomedical technology industry.

PRECISE's Professors Tai E Shyong, John Chambers and Patrick Tan elaborates on the new national body's efforts to drive personalised medicine in Singapore.

(L-R) Prof Patrick Tan, Executive Director, Prof Tai E Shyong, Chief Medical Officer, and Prof John Chambers, Chief Scientific Officer.

Images: PRECISE

Precision medicine has the potential to transform healthcare in Singapore. By tapping on genetic, clinical, environmental, lifestyle and other data, researchers and doctors could better predict individuals' risk of diseases, improve their diagnoses and develop targeted treatments for better health outcomes.

This has already been done for some diseases and treatments in Singapore. After scientists discovered that people with a gene variant called 'HLA-B*1502' have a higher risk of developing severe side effects to the drug carbamazepine, used to treat epilepsy, for example, the Health Sciences Authority recommended that everyone who is prescribed the drug should be tested for the variant first. Since then, there have been almost no cases of severe side effects.

To further boost Singapore's capabilities in precision medicine, the Government launched a 10-year National Precision Medicine (NPM) Programme in 2017. During the programme's first phase from 2017 to early this year, researchers created a database containing the genetic data of 10,000 healthy Singaporeans as a reference for future studies and experiments, among other work, and it is already being used by clinicians to improve healthcare.

Now, the Government has established Precision Health Research, or PRECISE, as the central entity to drive the programme's development in the remaining second and third phases.

A bold leap in research and healthcare

Professor Tai E Shyong, PRECISE's chief medical officer, explained that precision medicine is key to future-proofing Singapore's healthcare system. "In developed countries, governments can spend more and more on healthcare without much gain in health," he said. "Trying to do more of the same thing doesn't necessarily give rise to better health. Family history, for example, only scratches the surface of the genetic component, which can only explain up to 30 percent of health and disease."

"Given that we can now sequence the entire genome at lower and lower cost, precision medicine promises to uncover the precise genetic contribution to disease, to allow us to determine appropriate treatment more accurately."

He added that with the benefit of greater clarity, doctors can use their time in the clinic to more fully understand patients' concerns, and give personalised advice based on their genetic background, lifestyle and environment. "Precision medicine won't solve all the problems in healthcare, but through its considered use, we can produce a more efficient healthcare system that meets patients' needs."

In the NPM Programme's ongoing Phase 2, researchers will shed further light on Asians' genetic make-up by analysing the genomes of 100,000 healthy Singaporeans, with future plans to study patients with specific diseases.

Professor John Chambers, PRECISE's chief scientific officer, shared that besides the genome sequencing, the volunteers will contribute more data and a wider variety of biological samples to facilitate more research and innovation.

They will go through assessments of their health, lifestyle, behavioural and dietary choices, memory and thinking tests, and physical measurements to record their height, weight, blood pressure, arterial stiffness, and lung function.

"We will also conduct imaging tests, which will set us apart internationally in terms of the scope and strength of our research," Prof Chambers said.

DEXA scans, for example, will reveal the participants' body fat composition, skeletal strength and health, and bone mineral density that may highlight early signals of health and disease. "We will be able to look at their fat composition not just in total but regionally, meaning the fat in their abdomen versus legs, trunk or arms."

"This will allow us to really understand fat's relationship with metabolic health in general, and how fat in different parts of the body have different effects on human wellbeing."

Researchers will also collect more biological samples, including blood that will be preserved in a way to permit genomic studies, urine, stool, and skin cells drawn by applying tape to skin.

PRECISE also plans to link participants' research data to their clinical or health records, with their consent. "This will enable us to better understand their baseline health, diseases and medications, and, more importantly, track their future health."

"Such long-term follow-up through the medical records is an absolutely fundamental part of the research, because our primary goal is to understand the drivers of disease, and thus how we can reduce disease."

Building blocks for the future

The new phase will also span more research projects, pilots to embed genetics in clinics, and business possibilities for Singapore's healthcare and biomedical technology industry.

Prof Chambers said that eight research projects have been started, including one focusing on functional genomics. "Even if we know that a genetic variant is linked to a particular disease, we need to understand the biological pathway."

"If we discover that the variant causes the disease by changing the structure or function of a specific gene transcript, protein or metabolite, that opens up opportunities for diagnostic firms to develop new biomarkers, and pharmaceutical companies to design new drugs."

> **"...precision medicine promises to uncover the precise genetic contribution to disease, to allow us to determine appropriate treatment more accurately.**
>
> Prof Tai E Shyong
> Chief Medical Officer, PRECISE

As more researchers tap on the expanded database and initiate new projects, the building of capabilities and grooming of talent to support them will also strengthen Singapore in the long run, said Professor Patrick Tan, PRECISE's executive director.

"The work will require expertise in not just research and innovation, but high performance computing, cloud computing, data analytics, cybersecurity, start-up acumen and ecosystems to bring findings from bench to market, and, most importantly, public engagement efforts to ensure that the interests of Singaporeans are reflected in the programme."

"We want to tap the best in the public and private sectors to co-develop the NPM programme. This includes collaborating with companies, attracting overseas ones to come here and help build up capabilities, and galvanising new cadres of homegrown industries."

PRECISE will also partner with government agencies to identify talent gaps and train people to fill them, for instance through scholarships, courses to expand the skillsets of those working in adjacent fields, and recruitment of overseas experts to set up local training programmes.

"The research will generate many high-value jobs, including for skilled laboratory technicians, data analysts and allied health professionals, such as genetic counsellors who would look at patients' genetic information and work with them and their families to improve their health based on the data."

"When we have this larger skilled workforce, we will also draw more companies to Singapore that are hungry for qualified talent."

Prof Tai added that PRECISE will learn from the research projects to establish protocols. "We believe there will be common elements and lessons that emerge, and we will build these into frameworks to evaluate future projects, iterating as we go along, to check that we are looking at the right things and asking the right questions."

"Our work will not just deliver research, but put in place platforms for future research, clinical decision support systems, and screening pathways for every new technology that comes into healthcare. All of this will serve not just our interest in precision medicine, but prime our healthcare system for innovation."

For more information on PRECISE, please head over to www.npm.sg.

SPECIAL // ADVANCE HUMAN POTENTIAL

SCIENCE OF LEARNING PROGRAMME

In this commentary, **Dr Poon Chew Leng**, Divisional Director of the Research and Management Information Division at MOE, sheds light on what the new Science of Learning (SoL) research programme could do for Singapore.

Research to advance human potential is a new addition under the RIE2025 HHP domain.

The Human Potential (HP) research programme will take a life-course approach to seize new opportunities to enhance human potential, while helping to address some of the grand challenges of a rapidly ageing population in Singapore, coupled with low birth rates.

Hence, the three strategic focus areas under HP are a) prenatal and early childhood physical and emotional development, b) science of learning, and c) healthy and meaningful longevity.

Why the Science of Learning?

Education research has traditionally focussed on the social sciences – on how students interact with materials, the environment, significant adults and peers – to learn and grow. The emerging fields of neuroscience, cognitive science and augmented intelligence open up opportunities to develop both a deeper and more holistic understanding of the principles, processes and mechanisms of human learning.

SoL was adopted as a research paradigm as its multidisciplinary approach enables us to synthesise research from the health and biomedical sciences with insights from the social sciences to enhance human function, well-being and performance for young children, adolescents and adults.

What is Science of Learning?

The field of SoL investigates the biological basis of how we learn. Research funded by the SoL programme will include, but is not limited, to the fields of:

Neuroscience: understanding how the brain works at the cellular and molecular levels during learning and at different stages of our lives,
Cognitive science: understanding cognitive mechanisms at the psychological and behavioral levels in the context of learning; and
Augmentation of intelligence: exploring the use of technology to enhance human cognitive capabilities and/or accelerate learning.

Images: MOE, National Institute of Education (NIE)

Taking reference from Singapore's contexts, the SoL programme will give priority to the key areas of the science of a) literacy and b) numeracy development; the science of c) social and emotional learning, d) cognitive abilities and functions; and e) adult brain plasticity and development, among others.

The goal of the SoL programme extends beyond building a robust SoL foundation through groundbreaking research.

The ambition of the SoL programme is to also translate research findings into interventions and implement them to generate positive impact on the ground. This is reflected in our plan to concurrently fund both use-inspired basic and applied SoL research, which would increase the SoL knowledge base, while supporting the translation of existing mature research findings into effective learning and skills development interventions.

The impact we hope to achieve includes improving teaching and learning processes with informed pedagogy and andragogy, and scaling relevant early diagnosis and interventions for exceptional learners (from learners with special needs to the high ability learners) as well as supporting our mature workers for a start.

Additionally, this programme seeks to create a vibrant multi-disciplinary research community to build capabilities in the SoL eco-system. This would create a strong nexus of researchers, policy-makers and practitioners to deepen our understanding of how learners learn, and generate positive impact in schools, workplaces and the wider community.

Conclusion

RIE2025 is the start of a long journey to advance human potential. We hope to see meaningful and effective interventions and innovations informed by SoL in the next 5-10 years that will enhance the development and well-being of every Singaporean and help them maximise their potential.

HELP FOR THE HEART

Nuevocor is developing new solutions in gene therapies to overcome heart failure. Founding Chief Executive **Dr Tan Yann Chong** elaborates on its work.

The Singapore Therapeutics Development Review (STDR) is a national level funding scheme in RIE2025 that is implemented by A*STAR in partnership with its strategic partners, National Health Innovation Centre (NHIC), Singapore-MIT Alliance for Research and Technology (SMART), and the Experimental Drug Development Centre (EDDC).

It aims to support the HHP domain's goals of creating economic value by boosting the quality and quantity of the biotechnology pipeline in Singapore.

In the previous RIE2020 cycle, about half of the projects funded by STDR had downstream applications. One such project went on to form the biotechnology start-up Nuevocor, which is developing novel gene therapies for cardiomyopathies – a common cause of heart failure.

In fact, about one in 250 people worldwide suffer from dilated cardiomyopathy (DCM), a serious condition that reduces the heart's ability to pump blood and is a leading cause of heart failure. While drugs and implants can slow the disease's progress, the only cure is a heart transplant.

Nuevocor, a Singapore biotechnology start-up, is aiming to change this by creating innovative gene therapies for DCM caused by genetic mutations. Its current lead research programme is focused on DCM due to genetic mutations in the lamin A/C (LMNA) gene, which has among the worst outcomes for patients.

Image: Nuevocor

(L-R) Dr Tan, Dr Burke, and Dr Colin from Nuevocor.

"Conventional gene therapies that give you more of the 'normal' gene wouldn't work in this case, because the mutated gene would still be dominant and result in the disease," said Dr Tan Yann Chong, Nuevocor's founding chief executive officer.

Nuevocor's groundbreaking gene therapy targets a gene that encodes a protein of the nuclear envelope that interacts with LMNA, and is based on decades of research by Dr Colin Stewart and Dr Brian Burke, two of the firm's scientific co-founders who are also research directors at the Agency for Science, Technology and Research.

Dr Stewart discovered an unexpected link between LMNA and the interacting nuclear envelope protein when he was researching how LMNA mutations lead to various diseases, such as heart failure and muscular dystrophy. Colleagues had found that deficiencies in the interacting protein were also associated with some of the diseases.

"We thought that if we made mice that were doubly deficient in LMNA and its interactor, they would develop more severe diseases. Instead, and this is an amazing thing about genetics, the mice that were LMNA deficient or had LMNA mutations, and also lacked the gene for the interactor protein, had much longer lifespans and better health," Dr Stewart said.

"By taking away a second gene, we were able to suppress many of the pathologies associated with LMNA mutations."

Dr Burke, for his part, had independently created a mini version of the interactor protein that inhibits its function. The two scientists, who have been friends and intermittent colleagues for 35 years, decided to join forces. "This was a very happy convergence of two completely separate lines of research," Dr Burke said.

Nuevocor's cure for LMNA-related DCM uses the adeno-associated virus (AAV) to deliver the gene therapy. The virus does not cause human diseases and does not replicate in the body, making it an ideal vehicle for gene therapies.

Dr Mark Kay, who is director of the human gene therapy programme at Stanford University, and a leading expert in AAV-based therapy, is also one of Nuevocor's scientific co-founders.

The firm recently raised US$24 million (S$32 million) in funding from investors, which it will use to advance its research and bring its therapies closer to clinical trials. It is also developing a platform to identify similar disease-suppressing genes for other genetic cardiomyopathies.

Dr Tan summarised: "We hope to give patients a new lease of life through our work."

FEATURE

TAKING TELEHEALTH FORWARD

HiSEPOR founder **Dr Gao Jie** explains how its blood sampling kit could improve health screening and monitoring for the masses.

Images: HiSEPOR

Anyone who has had blood drawn for testing knows the hassle of traveling to a hospital or clinic, registering and waiting for the procedure.

Now, medical start-up HiSEPOR has created a simple home kit to draw and separate blood for health screening and monitoring.

About 80 per cent of health screening tests are performed using only the plasma in blood. The kit contains a lancet to draw blood, a dried plasma spot card that has slots with membranes to separate plasma from the rest of the blood, and packaging to mail the card that includes desiccants and antioxidants to keep the samples pristine during delivery.

"Instead of going to the hospital or someone from the hospital coming to your home, you can take a few drops of blood yourself at home. This will boost convenient and cost-effective access to health monitoring and screening for the masses, especially for chronic diseases," said Dr Gao Jie, HiSEPOR's founder.

The team plans to launch the kit in the near future in Singapore as a research tool first, before piloting its use for general health screening.

"We're also focusing on telehealth because it is a fast-growing and underserved market. We can reduce firms' costs in collecting and separating blood samples, and help them to expand to more markets, like chronic disease monitoring."

Dr Gao noted many telehealth firms use centrifuges to separate plasma from blood, which is time-consuming and labour-intensive when not automated.

"Blood samples also usually take a few hours to be sent to diagnostic labs for analysis. Delays in processing can cause cells in blood to break down, and their components to contaminate the plasma." It is also difficult to extract plasma from the typically small volumes of blood that are centrifuged.

HiSEPOR's prototype DPS separation kit.

The membranes in the home kits separate plasma passively, allowing almost total removal of non-plasma blood with minimal cell breakdown.

They are also made of a hydrophilic material that aids in plasma recovery, and can yield three times as much plasma passively as other plasma separation membranes in the market.

> **We're also focusing on telehealth because it is a fast-growing and underserved market. We can reduce firms' costs in collecting and separating blood samples, and help them to expand to more markets, like chronic disease monitoring.**
>
> Dr Gao Jie
> Founder, HiSEPOR

After plasma passes through the membrane, it is absorbed into filter paper in the slots and dried before the spot card is mailed.

HiSEPOR's prototype dried plasma spot card.

"These dry plasma samples are more stable than liquid ones. With the desiccants and antioxidants, they are stable for up to two weeks under normal conditions, enough time for the transport from home to lab," Dr Gao said.

HiSEPOR can also customise the membranes' pore size and chemistry for different uses. These could include membranes that bind specific cancer marker molecules in plasma, for cancer screening.

It is refining the membrane technology and applying for regulatory approval and certification for various clinical uses.

Dr Gao said: "With our innovation, we can provide solutions needed by telehealth and other partners."

HiSEPOR is a NUS Chemical and Biomolecular Engineering spin-off, supported by the NUS Graduate Research Innovation Programme (NUS GRIP), which provides step-by-step guidance to NUS postgraduate students and researchers to transform the university's world-class research into their own deep technology startups.

FEATURE

SOFTWARE TO TRAIN SOFT SKILLS

Co-founder of VIRTUAI **Maybelline Ooi** shares how virtual healthcare simulations are key to advancing training, especially in soft skills.

What should a doctor do if a patient and his family disagree on his care? How should a nurse react when receiving contradictory instructions? These are some scenarios that healthcare students and professionals could learn to handle through a desktop virtual reality programme created by National University of Singapore (NUS) healthcare spin-off VIRTUAI.

The programme uses customisable single player and multiplayer scenarios to teach soft skills such as critical thinking, bedside manners and how to communicate effectively with others in multidisciplinary teams.

VIRTUAI co-founder and chief executive Maybelline Ooi, an alumna of the NUS Alice Lee Centre for Nursing Studies (NUS Nursing) and former nurse, noted that while many healthcare start-ups focus on technical skills, soft ones are equally important in delivering quality patient care.

"With our programme, aspiring and practicing healthcare professionals can experience a wide variety of cases and circumstances, including medical errors and ethical dilemmas, that they may not come across in real-life clinical settings."

A nursing player interacts with an artificial intelligence (AI) doctor avatar on patient's care in a virtual futuristic ward.

In single player simulations, trainees could be tested on their ability to prioritise when faced with competing urgent demands, and their responses to medical errors. They could also be tasked with deducing the cause of a patient's illness based on his medical history, signs and symptoms and laboratory results.

By removing geographical and resource constraints, the programme also enables students and professionals from local and foreign institutions to come together easily for multidisciplinary and team-based training.

This would hone their interpersonal skills, especially when collaborating with others on patient care.

Led by principal investigator and pedagogy advisor Associate Professor Liaw Sok Ying, an NUS Nursing director of undergraduate education, the programme has been used to train nursing and medical students at NUS Nursing and the NUS Yong Loo Lin School of Medicine since 2017.

It was initially done in small-scale pilots before integration into their interprofessional core curriculum training last year. The programme will also be commercially available next year.

Images: VIRTUAI

A medical startup by healthcare professionals for healthcare professionals. `(L-R): CTO Zk Wong, CEO Maybelline Ooi, CMO Xuanny Ooi.

Ms Ooi added that the software has novel features that make it invaluable as a teaching tool. It can automatically generate virtual scenarios and environments from uploaded documents, such as case scenarios commonly used in teaching, by deploying key word recognition and word association.

Its performance analytics and data visualisation also tracks and highlights learners' strengths and weaknesses over time, with a recommendation engine suggesting scenarios to help them improve and advance through difficulty levels at their own pace.

Schools can also use students' performance data to make more informed decisions about curriculums and budget allocations, including to address recurring issues across learners and cohorts.

After VIRTUAI launches its programme, it will develop a premium product that covers technical skills by using extended reality headsets. The equipment will unlock virtual reality, augmented reality and mixed reality scenarios.

"By using the premium product with real-life mannequins, trainees could be immersed in a virtual operating room and practice their surgical skills on a mannequin with wounds superimposed on it," explained Ms Ooi.

VIRTUAI also plans to eventually build a platform marketplace where healthcare institutions can sell their customised virtual simulation modules, sharing their expertise and empowering students and professionals to learn from the best.

Ms Ooi envisioned: "We can bridge the disparity in global healthcare training standards, and use this opportunity to bring Singapore's top-notch healthcare trainings to the rest of the world."

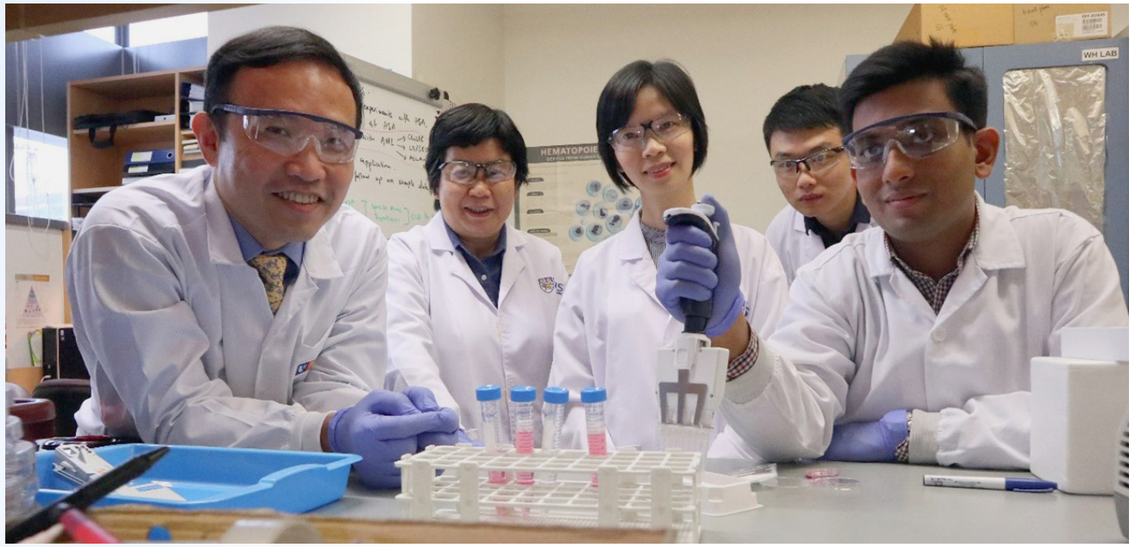
VIRTUAI founders have participated in multiple entrepreneurship programmes in NUS. This includes the NUS Overseas Colleges, to embark on start-up internships in entrepreneurial hotspots around the world, and the NUS GRIP, which nurtures deep tech entrepreneurial talent to transform research into startups.

FEATURE

GROWING STEM CELLS TO SAVE LIVES

Blood cancer patients will be able to speed up their recovery after undergoing cell therapy, with the help of a lab synthesised compound that can increase the number of stem cells. **Professor William Hwang**, Medical Director of the National Cancer Centre Singapore, shares more about this novel technology.

Images: Cordlife



*The C7 technology developed by the joint research team has the ability to expand blood stem cells while they maintain their quality and function as stem cells (from L-R: Prof William Hwang and Prof Christina Chai (NUS), Assoc Prof Gigi Chiu (NUS), Dr Zhong Qixing (A*STAR) and Dr Sudipto Bari (NCCS))*

Patients with blood cancer such as leukaemia and lymphomas have abnormal stem cells in their bone marrow, and these can sometimes be treated with drugs and chemotherapy.

In cases that require strong doses of chemotherapy, this can wipe out normal cells in the patients' bone marrow, so they are provided with fresh blood stem cells to repopulate the marrow.

Professor William Hwang, who has close to 25 years of experience in stem cell therapy and transplantation, explains that after the patients are given blood stem cells, it takes some time before the new cells can grow into a 'garden' of different cells, such as red and white blood cells.

For bone marrow transplants, this process takes at least two weeks, and around three to four weeks for patients who have received cord blood therapy.

But due to the low cell count during this period, patients are more susceptible to life-threatening infections.

To address this challenge, Prof Hwang and researchers from the National University of Singapore (NUS) Department of Pharmacy developed a novel technology that uses a laboratory synthesised compound called C7 to expand the number of haematopoietic stem and progenitor cells (HSPCs), or blood-forming cells, from stored umbilical cord blood.

"Blood stem cell expansion can help to increase the number of cells that is given to the patients at transplant, which can help speed up their recovery process," says Prof Hwang.

Prof Hwang is currently the Medical Director of the National Cancer Centre Singapore, Head of SingHealth Duke-NUS Cell Therapy Centre and faculty at the Cancer and Stem Cell Biology Programme at Duke-NUS Medical School.

Transplanting blood stem cells from umbilical cord blood is one of the most effective treatments for blood cancer patients, but the number of stem cells that can be harvested via this method is often insufficient for adult transplant patients. There are around 250 to 300 patients each year in Singapore requiring stem cell therapy, who will be able to benefit from the new technology.

Prof Hwang described the research journey for C7 compound as "almost an incidental finding". He and his team were collaborating with NUS Pharmacy researchers to screen a novel library of azole based small molecules to study its effect on blood stem cell expansion, which led to the discovery of the C7 compound's effects.

"The C7 technology is currently the best method to grow large numbers of stem cells, and it has achieved better pre-clinical results compared to other compounds. The C7 compound has the ability to expand banked cord blood stem cells while they maintain their quality and their status as stem cells," he says.

Looking ahead, SingHealth Duke-NUS Academic Medical Centre (AMC) will be working with Singapore's first private cord blood bank, Cordlife Group Limited (Cordlife), to test the C7 technology in a first-in-human study in Singapore. This is the first time a home-grown umbilical cord blood cell therapy is tested on blood cancer patients here.

Singapore's first private cord blood bank, Cordlife, extracts stem cells from cord blood and prepares it for long-term cryopreservation.

The pilot study is expected to begin in a few months' time at Singapore General Hospital and will involve five patients for a start.

Prof Hwang hopes to extend the indications for haematopoietic stem cells beyond cord blood transplantation, to include expansion of these cells for bone marrow and peripheral blood stem cell transplants, as well as to enhance the effects of blood stem cell gene therapy.

FIGHT A GENE, SAVE A LIVER

Duke-NUS and National Heart Centre Singapore researchers discovered that the interleukin 11 (IL11) gene has a damaging effect on liver cells. This immunofluorescence image shows IL11 activity in dying liver cells.

The team found that IL11 is important for toxin-induced liver failure, overturning several earlier studies that erroneously suggested that IL11 could protect livers. These new findings will change scientists' understanding of IL11 and thus, suggest a new way to treat terminal liver failure.

The researchers are now studying whether anti-IL11 therapy can reverse kidney failure: a common, costly and currently irreversible health issue in Singapore, as well as exploring the wider role of IL11 in ageing diseases.

Image: Duke-NUS Medical School

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