



APRIL 2020 – MARCH 2021

ANNUAL REPORT

Creating Growth, Enhancing Lives

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Our Mission

The Agency for Science, Technology and Research (A*STAR) drives mission-oriented research that advances scientific discovery and technological innovation. We play a key role in nurturing and developing talent and leaders for our research institutes, the wider research community, and industry.

Our research creates economic growth and jobs for Singapore. As a Science and Technology Organisation, we bridge the gap between academia and industry in terms of research and development. In these endeavours, we seek to integrate the relevant capabilities of our research institutes and collaborate with the wider research community as well as other public sector agencies towards meaningful and impactful outcomes.

Together with the other public sector entities, we develop industry sectors by: integrating our capabilities to create impact with multi-national corporations and globally competitive companies; partnering local enterprises for productivity and gearing them for growth; and nurturing R&D-driven start-ups by seeding for surprises and shaping for success.

Our research, in addition, also contributes to societal benefits such as improving outcomes in healthcare, urban living, and sustainability. These serve to enhance lives in Singapore and beyond.

Our Vision

A global leader in science, technology and open innovation.

A*STAR is a catalyst, enabler and convenor of significant research initiatives among the research community in Singapore and beyond. Through open innovation, we collaborate with our partners in both the public and private sectors, and bring science and technology to benefit the economy and society.



Message from the Chairman and CEO

This time last year, we were grappling with the significant disruptions of COVID-19, and still learning how to cope with the raging pandemic.

While we are not out of the woods, Singapore as a whole is now better prepared to deal with COVID-19.

Science, technology and innovation have been critical in mitigating the effects of the pandemic. Long-term R&D investments by the ecosystem have enabled A*STAR to play our part to help Singapore respond decisively to combat COVID-19.

For instance, made-in-Singapore diagnostic kits have played a significant role in detecting COVID-19, both at home and abroad. The Diagnostics Development (DxD) Hub, a national platform hosted by A*STAR, has facilitated

the development of 10 different COVID-19 diagnostic tests with public and private sector partners. These include the Fortitude and Resolute 2.0 diagnostic tests, and accompanying automated liquid handling systems. DxDHub has also systematically transferred technology know-how to biotech companies, who have since gone on to manufacture kits to fulfil local and international demand.

In terms of tracking virus mutations globally, our scientists at the Bioinformatics Institute have contributed to the genetic and evolutionary analysis of SARS-CoV-2 via the Global Initiative on Sharing All Influenza Data (GISAID).

These examples underscore the importance of basic science in fueling an innovation pipeline to secure Singapore's economy, society, and future, as the seeds of today's response were planted many years ago.

At A*STAR, we are proud of our basic research that has helped push the frontiers of science for the local ecosystem, and internationally.

Through our applied and translational research, A*STAR contributes actively to the digitalisation and innovation journey of our industry partners, especially our local enterprises, particularly to help them emerge stronger from the COVID-19 crisis.

In partnership with the public sector, we are also helping to address national challenges to better serve Singapore and Singaporeans in areas such as food security, improving health and human potential outcomes, as well

as promoting the sustainability and liveability of our built environment.

We nurture a pipeline of scientific talent for the local R&D ecosystem, so that Singapore can maintain its position as one of the most innovative economies in the world. In the last five years, more than 350 A*STAR scholars have completed their PhD or post-doctoral education, and are now actively contributing to Singapore's RIE ecosystem via multiple pathways in academia, industry and the public sector.

This year, we embark on a new Research, Innovation, and Enterprise tranche, RIE2025. The government has decided to invest S\$25 billion for the next five years to drive research and innovation across the Manufacturing, Trade and Connectivity, Human Health and Potential, Urban Solutions and Sustainability, as well as Smart Nation and the Digital Economy domains.

A*STAR will continue to build deep capabilities in areas such as sustainability and Industry 4.0, as well as medtech and novel foods to tackle a spectrum of national needs, and enhance our local R&D ecosystem's competitive advantage over the longer-term. We will contribute to the efforts in positioning Singapore as a Global-Asia node of technology, innovation, and enterprise.

As we mark A*STAR's 30th anniversary this year, we continue to be committed to Singapore, Singaporeans and Science. We will continue to do our best and live by our motto: creating growth, enhancing lives.



Ms Chan Lai Fung
Chairman

Mr Frederick Chew
Chief Executive Officer



Board Members (as of 31 March 2021)

Chairman

1. Ms Chan Lai Fung

Chairman
A*STAR
Permanent Secretary (National Research & Development)
National Research Foundation

Members

2. Mr Frederick Chew

Chief Executive Officer
A*STAR
Chief, Public Sector Science & Technology Policy & Plans Office
Prime Minister's Office

3. Professor Barry Halliwell

Chairman
Biomedical Advisory Council, A*STAR
Senior Advisor
Academic Appointments and Research Excellence, Office of the Senior Deputy President and Provost, Tan Chin Tuan Centennial Professor Department of Biochemistry, National University of Singapore

4. Professor Sir John O'Reilly

Chairman
Science and Engineering Advisory Council, A*STAR
Chairman
NICC (Standards)

5. Professor Isaac Ben-Israel

Chairman
Israel Space Agency

6. Mr Ashok Belani

Executive Vice President
New Energy
Schlumberger Limited

7. Professor Stefan Catsicas

Managing Partner
Skyviews Lifescience SA

8. Mr Chia Song Hwee

Deputy Chief Executive Officer
Temasek International

9. Professor William Chin

Bertarelli Professor of Translational Medical Science and Medicine Emeritus
Harvard Medical School
Executive Vice President
Clinical & Translational Science, Frequency Therapeutics

10. Mr Chng Kai Fong

Managing Director
Economic Development Board

11. Professor Jackie Hunter

Board Director
BenevolentAI

12. Dr Benjamin Koh Khay Wee

Deputy Secretary (Development)
Ministry of Health

13. Professor Lily Kong

President
Singapore Management University

14. Dr Josephine Kwa

Director
Barghest Building Performance

15. Mr Arunjai Mittal

Chairman
Advanced Micro Foundry

16. Mr Quek Gim Pew

Senior R&D Consultant
Ministry of Defence

17. Mr Ravinder Singh

Group Chief Operating Officer (Technology & Innovation)
President,
Defence & Public Security
ST Engineering

18. Mr Soh Gim Teik

Partner
Finix Corporate Advisory

19. Professor Subra Suresh

President
Nanyang Technological University

20. Professor Tan Eng Chye

President
National University of Singapore

21. Mr Yee Ping Yi

Deputy Secretary (Planning)
Ministry of Finance

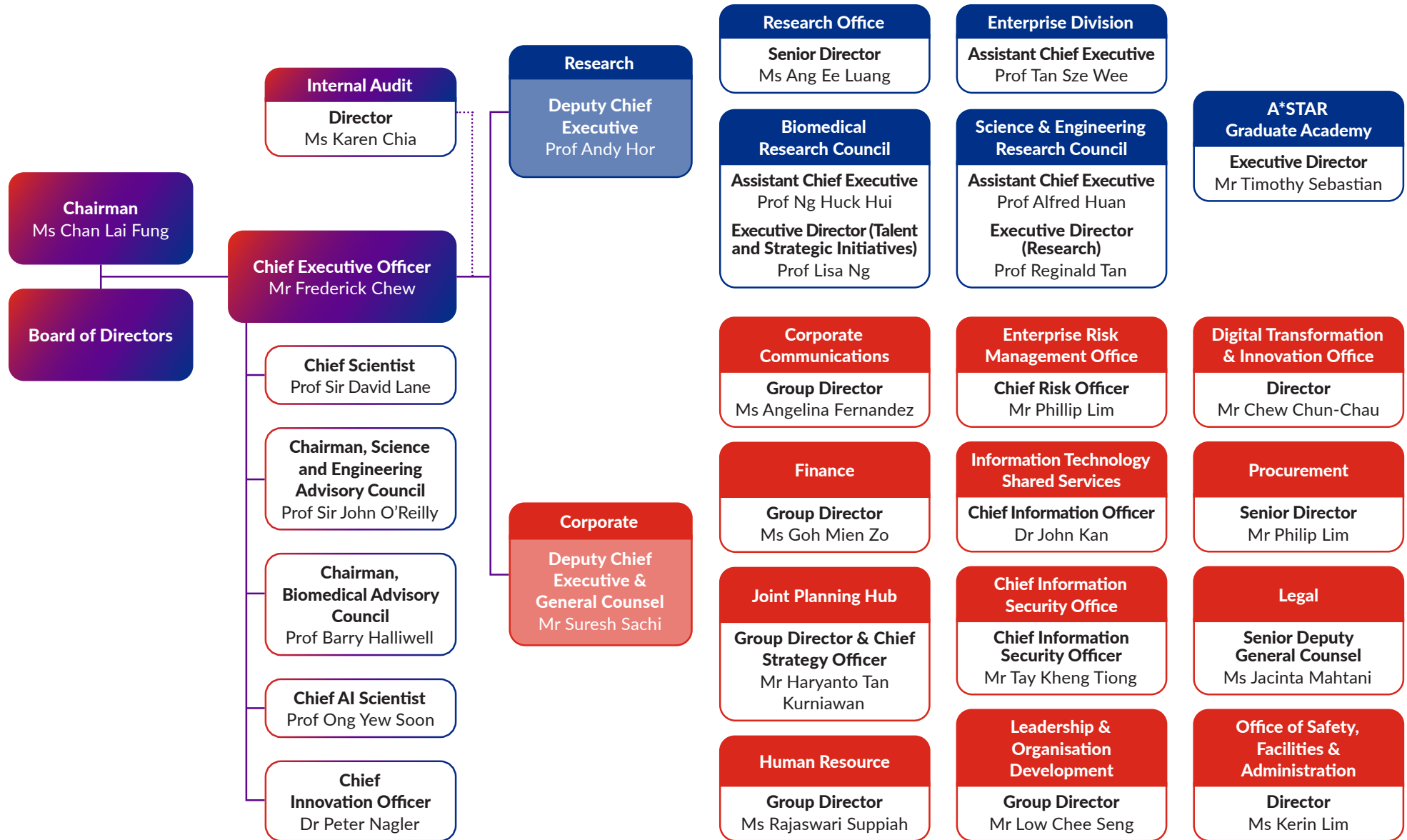




A*STAR Senior Management (as of 31 March 2021)

- 1. Mr Frederick Chew**
Chief Executive Officer
A*STAR
Chief, Public Sector Science & Technology Policy & Plans Office
Prime Minister's Office
- 2. Mr Suresh Sachi**
Deputy Chief Executive (Corporate)
General Counsel
- 3. Professor Andy Hor**
Deputy Chief Executive (Research)
- 4. Professor Ong Yew Soon**
Chief Artificial Intelligence Scientist
A*STAR
President's Chair Professor of Computer Science
Nanyang Technological University
- 5. Dr Peter Nagler**
Chief Innovation Officer
A*STAR
Executive Director
Institute of Chemical & Engineering Sciences
- 6. Professor Barry Halliwell**
Chairman
Biomedical Advisory Council, A*STAR
Senior Advisor
Academic Appointments and Research Excellence, Office of the Senior Deputy President and Provost, Tan Chin Tuan Centennial Professor
Department of Biochemistry, National University of Singapore
- 7. Professor Sir John O'Reilly**
Chairman
Science and Engineering Advisory Council, A*STAR
Chairman
NICC (Standards) Ltd
- 8. Professor Ng Huck Hui**
Assistant Chief Executive
Biomedical Research Council
- 9. Professor Alfred Huan**
Assistant Chief Executive
Science & Engineering Research Council
- 10. Professor Tan Sze Wee**
Assistant Chief Executive
Enterprise
- 11. Mr Timothy Sebastian**
Executive Director
A*STAR Graduate Academy

Organisation Chart (as of 31 March 2021)



Subsidiary Company

Name of Subsidiary Company

Accelerate Technologies Pte Ltd (A*ccelerate)

A*STAR's % of shareholdings in company

100%

A*ccelerate was established to commercialise the Intellectual Property portfolio of the Agency for Science, Technology and Research (A*STAR) as well as to hold and manage its spin-off activities.

As of January 2021, the functions and staff of A*ccelerate were incorporated into A*STAR's Enterprise division. Enterprise supports A*STAR in transforming the economy by driving innovation and commercialising A*STAR's research outcomes. Together with the public sector, industry partners and the research community, Enterprise leverages innovation to help Singapore companies grow and be more competitive, facilitates the growth of deep tech startups in Singapore and supports national platforms to drive the productisation efforts of enterprises.

A*ccelerate will continue to hold license agreements and equity in spin-off companies.

A*ccelerate subsidiaries

- A*ccelerate Venture Creation Pte Ltd
- A*STAR (Suzhou) Co. Ltd

For more information, visit

<https://www.a-star.edu.sg/enterprise>

Our Institutions and Platforms

The A*STAR community spans a broad range of research areas from the biomedical sciences to the physical sciences and engineering. The community of scientists and researchers, technical and non-technical staff, and industry development, commercialisation and corporate staff were 5,500 strong as of 31 March 2021.

Biomedical Research Entities

- Bioinformatics Institute (BII)
- Bioprocessing Technology Institute (BTI)
- Genome Institute of Singapore (GIS)
- Infectious Disease Labs (ID Labs)
- Institute of Bioengineering and Nanotechnology (IBN)
- Institute of Medical Biology (IMB)
- Institute of Molecular and Cell Biology (IMCB)
- Singapore Bioimaging Consortium (SBIC)
- Singapore Institute for Clinical Sciences (SICS)
- Singapore Institute of Food and Biotechnology Innovation (SIFBI)
- Singapore Immunology Network (SIgN)

Science and Engineering Research Entities

- Institute of Chemical and Engineering Sciences (ICES)
- Institute of High Performance Computing (IHPC)
- Institute for Infocomm Research (I²R)
- Institute of Materials Research and Engineering (IMRE)
- Institute of Microelectronics (IME)
- Singapore Institute of Manufacturing Technology (SIMTech)

National Platforms

*Platforms managed by A*STAR but funded nationally.*

- Diagnostics Development (DxD) Hub
- Experimental Drug Development Centre (EDDC)
- National Metrology Centre (NMC)
- National Robotics R&D Programme Office (NR2PO)
- National Supercomputing Centre (NSCC)
- Singapore Biodesign (SB)
- Technology Centre for Offshore and Marine, Singapore Ltd (TCOMS)

Horizontal Technology Programme Offices

- AgriTech & Aquaculture
- Artificial Intelligence, Analytics and Informatics
- Health & MedTech
- Infectious Disease
- Robotics
- Social Sciences & Technology
- Urban and Green Technology

Joint Institutions

- Advanced Remanufacturing and Technology Centre (ARTC)
- Skin Research Institute of Singapore (SRIS)

A*STAR's Achievements in Research, Innovation and Enterprise (RIE) 2020

SUSTAINING SINGAPORE'S FUTURE ECONOMY & SOCIETY THROUGH SCIENCE, TECHNOLOGY AND INNOVATION



Raising Local Enterprises' Productivity and Growth

2,400 projects with local enterprises

>80%

with SMEs and Start-ups

>440 companies reached through sector-specific Consortium Operation & Technology Roadmapping (OTR) with A*STAR

86 companies underwent 1-to-1 OTR with A*STAR

324 A*STAR Research Scientists and Engineers seconded to help companies scale up & innovate



Enabling Trade and Connectivity

>600 industry projects in this sector which attracted **>\$180M** in R&D investments from other companies



Strengthening Innovation and Enterprise

PRODUCTISATION & SPIN-OFFS

>90

A*STAR Spin-offs

>\$300M

Attracted of follow-on funding

LICENSING

>1,100

licences taken up by companies

>60%

to SMEs and spin-offs



Contributing to Public Sector Transformation

>750 projects undertaken with public sector agencies



Supporting the Future of Manufacturing

Around **130** companies engaged through Model Factory initiatives



Advancing Great Science

1.85 A*STAR publications' average Field-Weighted Citation Impact in RIE 2020*

*85 per cent more cited than expected according to the global average

10,856

high-impact publications (More than half published in Top 10% of Journals)



Attracting and Building Pipeline of STEM Talent

>350 A*STAR scholars completed their PhD or post-doctoral education, and contributing to Singapore's RIE ecosystem

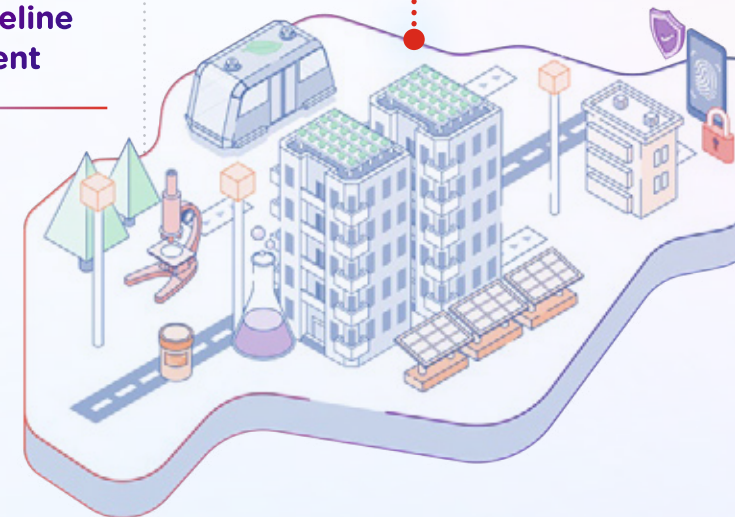
A*STAR is ranked **Top Employer of Choice**

for students in the engineering and natural sciences industry

— Universum 2021

>6,000

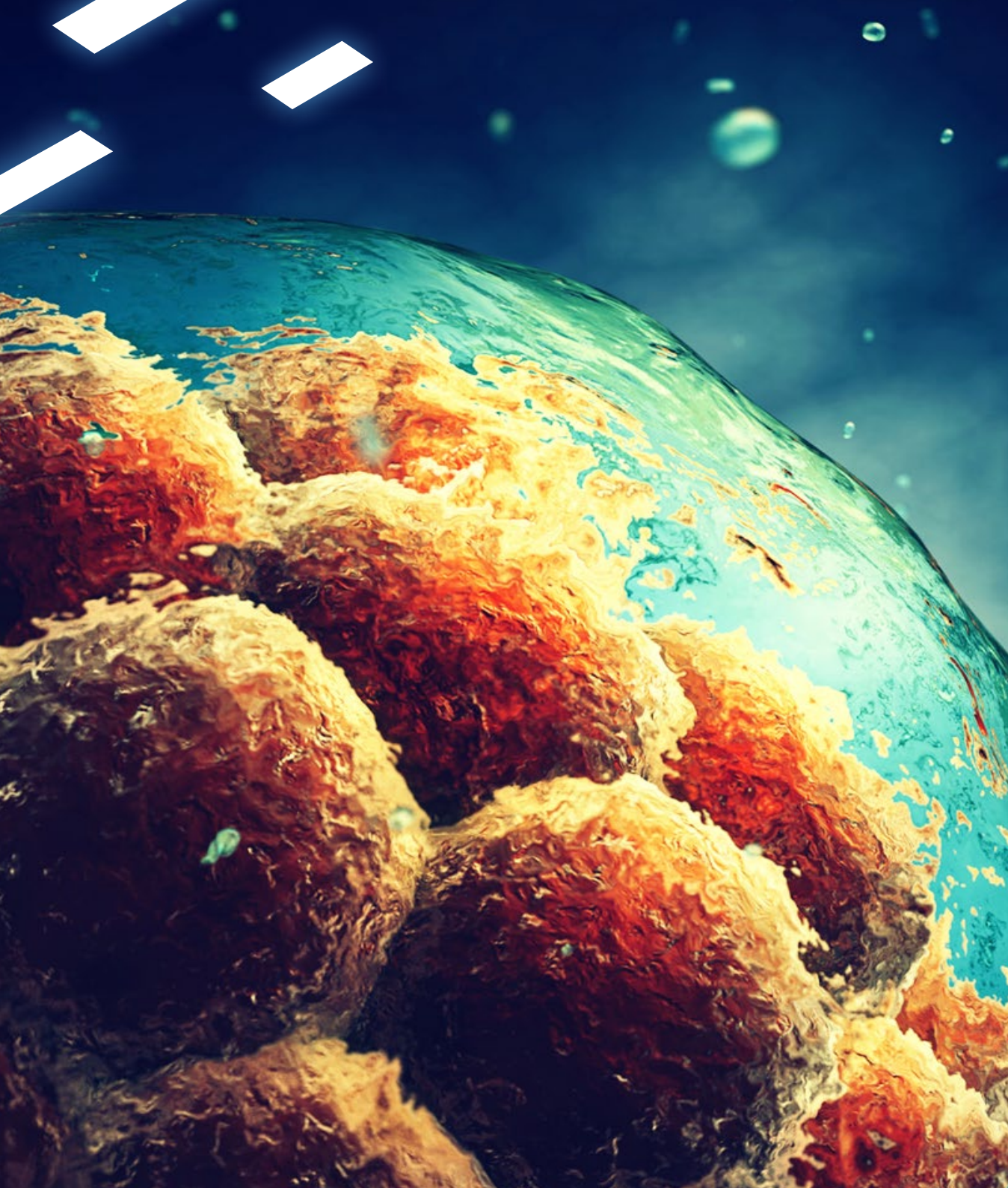
projects undertaken with companies



KEY ACHIEVEMENTS

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Driving Excellent Use-Inspired Basic Research

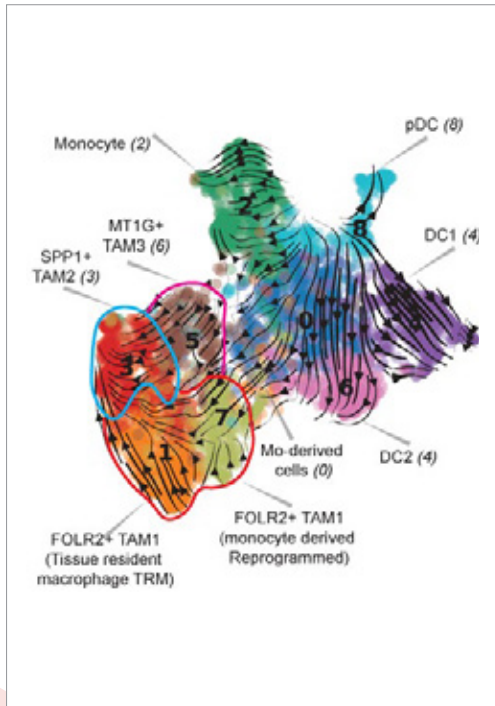
As a world-class research organisation, A*STAR is building an innovation pipeline to secure Singapore's future and its status as a global innovation hub. Here are the highlights of our achievements in use-inspired basic science and high-impact R&D.



◀ An embryonic cell

MAKING AN IMPACT WITH NEW SCIENTIFIC KNOWLEDGE

Biomedical Research



▲ Steady state RNA velocity: Directionality of myeloid cell states predicted by RNA velocity suggest tumour macrophages are derived from reprogrammed monocytes.

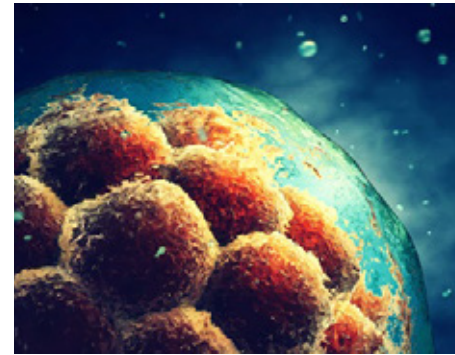
Tumors Hide by Mimicking Foetal Characteristics to Gain Immune Tolerance ✨

Discovery of how tumours gain immune tolerance by activating cellular mechanisms involved in foetal development.

Ramanuj DasGupta
Genome Institute of Singapore (GIS)

Florent Ginhoux
Singapore Immunology Network (SigN)

[Onco-fetal Reprogramming of Endothelial Cells Drives Immunosuppressive Macrophages in Hepatocellular Carcinoma](#) ✨
Cell



▲ The protein keratin—found abundantly in our hair and nails—plays an important role during embryonic development.

Keratin's Role in Determining Embryonic Cell Fate ✨

How keratins play a function in specifying which cells of the embryo go on to be the precursor of the placenta.

Nicolas Plachta
Institute of Molecular & Cell Biology (IMCB)

[Keratins are Asymmetrically Inherited Fate Determinants in the Mammalian Embryo](#) ✨
Nature



▲ Mutations in a gene called NUA2 have been identified as a cause of anencephaly, a common defect in developing fetuses.

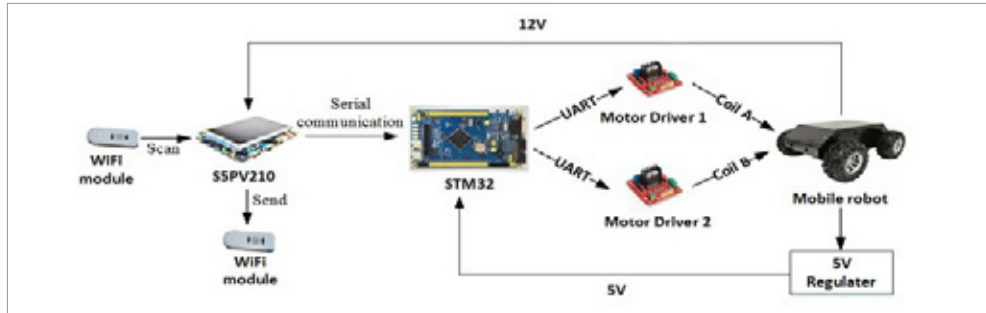
Mutated Gene Impairs Foetal Brain Formation ✨

Identification of a mutated gene whose malfunction impairs brain formation in developing fetuses.

Bruno Reversade, IMCB

[A Loss-of-function NUA2 Mutation in Humans Causes Anencephaly due to Impaired Hippo-YAP Signaling](#) ✨
Journal of Experimental Medicine

Science and Engineering

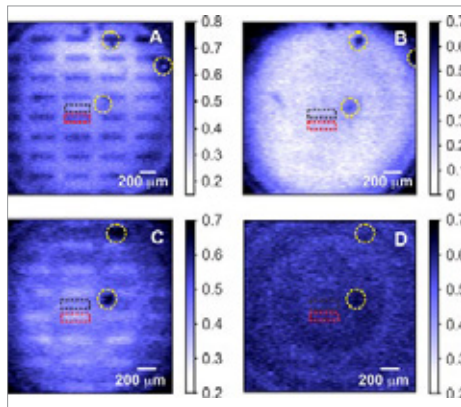


▲ Researchers from I²R designed a lightweight indoor robot positioning system which operates on cost-effective WiFi-based received signal strength.

WiFi-Based Deep Learning Model for Indoor Robot Positioning

Development of a deep learning technique to help robots navigate new environments, and “see” in situations without a clear line of sight, or when backgrounds are featureless.

Zhang Le
Institute for Infocomm Research (I²R)
[WiFi-Based Indoor Robot Positioning Using Deep Fuzzy Forests](#) ✨
 IEEE Internet of Things Journal



▲ Hyperspectral IR microscopy

Accessible Hyperspectral Infrared Microscopy

With a method known as induced coherence, our researchers were able to transfer information captured by an infrared beam to a visible beam of light, which could then be measured by off-the-shelf equipment.

Leonid Krivitsky
Institute of Materials Research and Engineering (IMRE)
[Hyperspectral Infrared Microscopy with Visible Light](#) ✨
 Science Advances



▲ SIMTech robotic hybrid laser-aided additive manufacturing system.

In-Situ Point Cloud Processing With Machine Learning For Surface Monitoring

Development of a novel way to monitor and quickly detect surface defects in additive manufacturing.

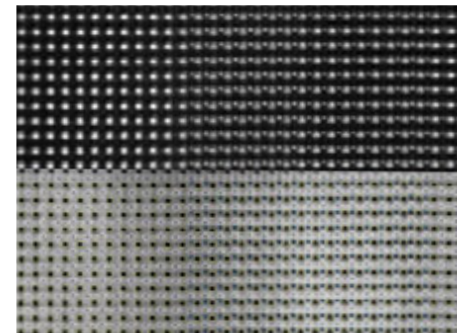
Bi Guijun and Yao Xiling
Singapore Institute of Manufacturing Technology (SIMTech)

[Rapid Surface Defect Identification for Additive Manufacturing with In-situ Point Cloud Processing and Machine Learning](#) ✨
 Journal of Virtual and Physical Prototyping

Piezoelectricity Made Simple ✨

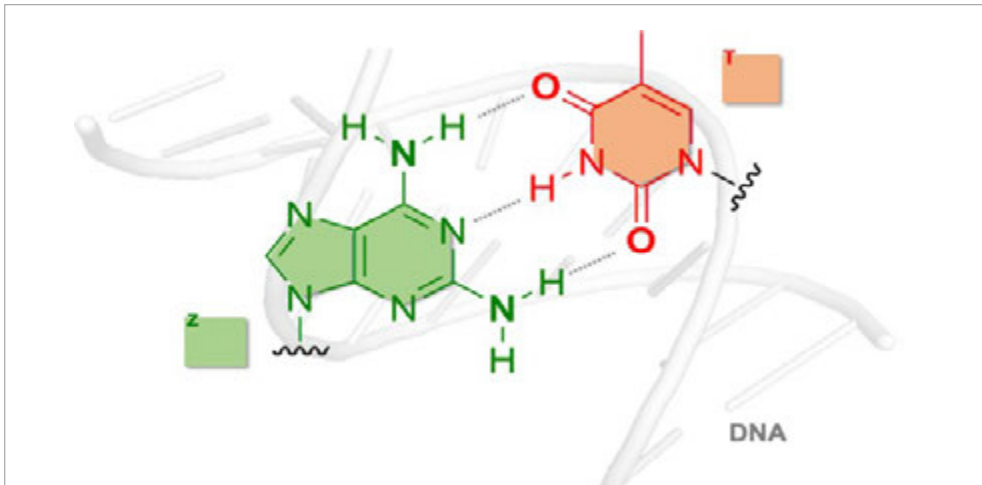
Finding a simpler, safer and more environmentally-friendly way to enhance piezoelectric response using nanopillar structures within solid materials.

Kui Yao, IMRE
[Giant Piezoelectricity in Oxide Thin Films with Nanopillar Structure](#) ✨
 Science



▲ High-angle annular dark-field (top) and bright field images (bottom) of a cross-section of the nanopillar material, showing structural distortions that enhance the material's piezoelectric performance.

COLLABORATING WITH INTERNATIONAL RESEARCH PARTNERS



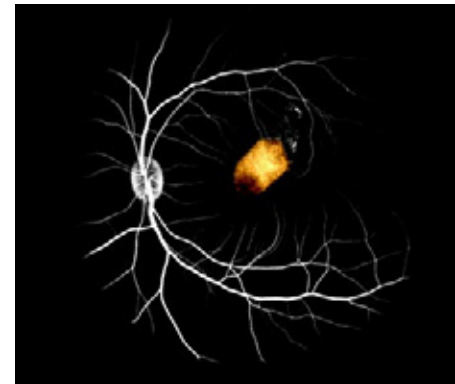
▲ Modified Z base forms a triple bond with a T base on the complementary DNA strand.

Bacteriophage DNA Modifications

A collaborative study with researchers from China and US led to the discovery of the mechanism for synthesis of DNA genomes containing the bases ZGTC, instead of AGTC in regular DNA.

A*STAR's Singapore Institute of Food and Biotechnology Innovation (SIFBI), ShanghaiTech University and Tianjin University in China, and the University of Illinois at Urbana-Champaign in USA

[A Widespread Pathway for Substitution of Adenine by Diaminopurine in Phage Genomes](#)
Science



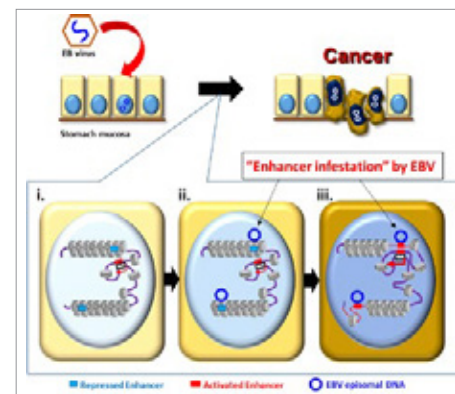
▲ RPE implant embedded in the sub-retinal space of a model.

Treating Blindness Using Retinal Cell Transplant

We partnered researchers from Germany, US and Singapore to study the degeneration of the retinal pigment epithelium, a major cause of visual impairment. The team also demonstrated potential restoration of lost vision using cell replacement therapy.

A*STAR's IMCB, Icahn School of Medicine at Mount Sinai (New York), Singapore Eye Research Institute, National University of Singapore and Eye Clinic Sulzbach (Germany)

[Surgical Transplantation of Human RPE Stem Cell Derived RPE Monolayers into Nonhuman Primates with Immunosuppression](#)
Stem Cell Reports



▲ Cross species chromatin interactions drive transcriptional rewiring in EBV positive gastric adenocarcinoma.

Epstein-Barr Virus (EBV) Infections' Role in the Development of Stomach Cancer

With researchers from Japan and Singapore, we uncovered how EBV infection plays an important role in the development of EBV-associated gastric cancer.

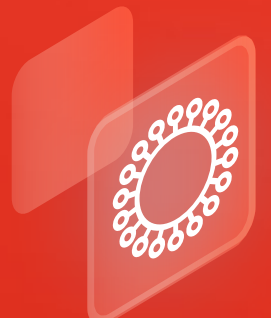
A*STAR's GIS, Chiba University (Japan) and Duke-NUS Medical School (Singapore)

[Cross-species Chromatin Interactions Drive Transcriptional Rewiring in Epstein-Barr Virus-positive Gastric Adenocarcinoma](#)
Nature Genetics



Fighting COVID-19 with Research and Innovation

Singapore's ability to respond to the COVID-19 pandemic can be attributed to the synergistic relationships cultivated with infectious disease scientists and the clinical community since the 2003 SARS outbreak. This is complemented by strong links between local researchers and the international scientific community.



◀ Operator from the Stronghold Diagnostics Lab working on COVID-19 test samples. The lab boosts the nation's testing capacity.

DIAGNOSTIC KITS

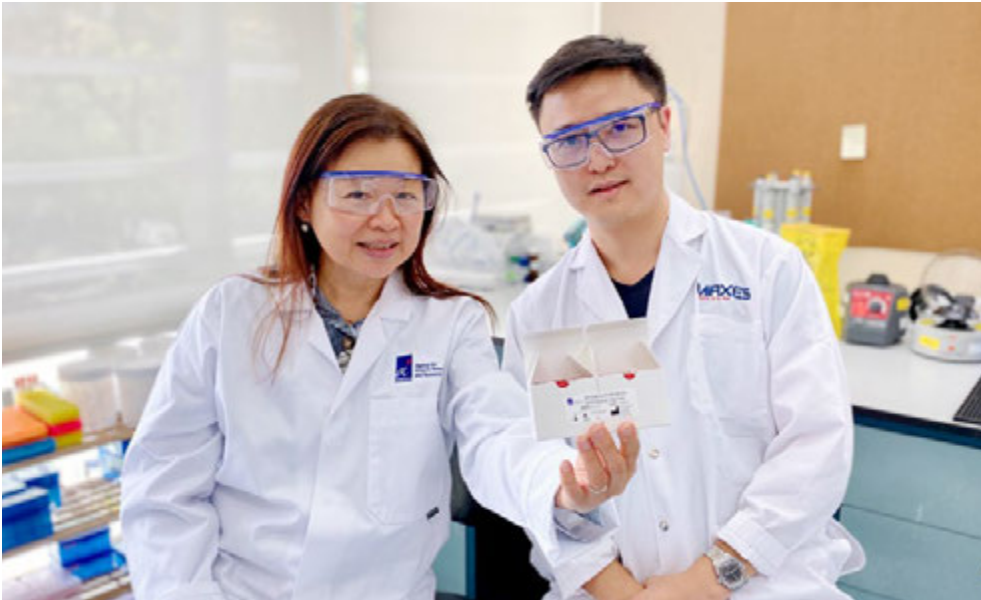
By enabling accurate and safe testing of COVID-19, we help curb the spread of the pandemic in Singapore and beyond



▲ DxD Hub scientist loading samples into a test kit reaction mix.

Bringing COVID-19 Test Kits from Bench to Bedside

The [Diagnostics Development \(DxD\) Hub](#) plays a critical role in enabling the local research, innovation and enterprise ecosystem to fight the COVID-19 pandemic. To date, the platform has driven the development of 10 COVID-19 diagnostic tests with public and private sector partners. It has also supported the verification, optimisation, validation and productisation of cutting-edge COVID-19 solutions. By transferring the technological know-how to biotech companies to scale-up and manufacture kits for local and international markets, DxD Hub has facilitated the deployment of more than six million Fortitude tests to 45 countries, and the joint Resolute 2.0 kits (co-developed with DSO National Laboratories) and Rapid Automated Volume Enhancer (RAVE) systems to hospitals in Singapore.



▲ Dr Sidney Yee, CEO of DxD Hub, holding up the Fortitude Kit, with Dr Zhou Lihan, CEO of MiRXES, manufacturer of the test kits.

Expanded Fortitude Kit Receives HSA Provisional Approval

Building upon Singapore's first COVID-19 hospital lab diagnostic test kit, which was given provisional authorisation by the Health Sciences Authority (HSA) back in February 2020, DxD Hub and Tan Tock Seng Hospital (TTSH) have developed an

[expanded Fortitude Kit](#) that can test for COVID-19 as well as influenza A and B. This new kit enables healthcare professionals to make more accurate and speedy diagnoses and distinctions between COVID-19 and the flu, as both lead to similar symptoms.

Resolute 2.0 Approved for Deep Throat Saliva Testing in Singapore

Developed by DxD Hub and DSO National Laboratories, [Resolute 2.0 is a breakthrough Direct-Polymerase Chain Reaction \(PCR\) COVID-19 diagnostic test kit](#). It does away with the need for extraction of viral RNA from patient test samples, thereby minimising potential human errors and halving the time of a conventional PCR test which takes at least 2.5 hours. Resolute 2.0

works with both deep throat saliva and throat samples, as well as conventional nasal swab samples. Saliva sample collection is much less invasive and more comfortable for patients than deep-throat and nasal swabs. It is also easier to administer and allows patients to provide their own samples, mitigating the risks of potential virus spread.



▲ Resolute 2.0 Direct-PCR COVID-19 diagnostic test kit

ANALYTICS AND DETECTION

Supporting global sharing of virus sequences and boosting national testing capacity

BII Scientists Contribute to Genetic and Evolutionary Analysis of SARS-CoV-2

Scientists at A*STAR's Bioinformatics Institute (BII) and the Genome Institute of Singapore, led by BII executive director Dr Sebastian Maurer-Stroh, have been busy [tracking the genetic and evolutionary changes of SARS-CoV-2](#). Their work in tracking the virus, which has already mutated thousands of times since the

start of the pandemic, involves collecting and analysing changes to the viral genome under the Global Initiative on Sharing All Influenza Data (GISAID) data-sharing platform. To date, more than 2.5 million virus sequences have been shared, supporting the global development of diagnostics kits, therapeutics and vaccines.

Punching above its weight in global fight against Covid-19

Team from Spore's A*Star played major role in database on genomes of virus

Salma Khalik
Senior Health Correspondent

Singapore has punched above its weight in the fight against the Covid-19 pandemic with the expertise it provided to enable the rapid sharing of genomes of the virus. This not only helped the World Health Organisation (WHO) and governments around the world to respond faster, but also sped up the development of much-needed vaccines and diagnostic kits.

It has been a year since the first five fully sequenced SARS-CoV-2 virus genomes were made public by laboratories in China via the Global Initiative on Sharing All Influenza Data, or GISAID, on Jan 10 last year.

Since then, the sequence of more than 360,000 genomes of the virus causing the Covid-19 pandemic, submitted by more than 145 countries, has been shared.

The team from Singapore's Agency for Science, Technology and Research (A*Star) played a major role in setting up and maintaining the database to share and analyse the genomes.

Under the watch of Dr Sebastian Maurer-Stroh, executive director of the Bioinformatics Institute (BII), it helped to quickly check the genome sequences sent in by various countries.

It may not have been the first player in the game, but GISAID raised the bar.



Amid the challenges brought on by the pandemic, a team from the Agency for Science, Technology and Research has played a major role in setting up and maintaining a database to share and analyse the genomes of the Sars-CoV-2 virus, helping to speed up the development of vaccines and diagnostic kits. ST PHOTO: LIM YACHU

Major clades and spread of the Sars-CoV-2 virus



From left: GISAID president Peter Bognner, Bioinformatics Institute (BII)

Source: The Straits Times © Singapore Press Holdings Limited. Permission required for reproduction.

Singapore beefing up defences in preparation for Disease X

Deeper tie-ups needed between R&D ecosystem and private firms: DPM

Audrey Tan
Science Correspondent

Singapore is continuing to strengthen its defences against future infectious diseases, even as the national Covid-19 vaccination drive continues.

The strong partnership between researchers at the Agency for Science, Technology and Research (A*Star), the broader research and development ecosystem and private companies has been vital for Singapore's collective response to the pandemic, said Deputy Prime Minister Heng Swee Keat yesterday.

"It is important that we continue to strengthen and deepen the collaborations. In this way, we will be better prepared for future pandemics, including Disease X," he said in a Facebook post, following his visit on Monday to the Stronghold Diagnostics Lab - a Covid-19 testing facility located at Biopolis, Singapore's biomedical hub in Buona Vista.

The laboratory was set up to



TESTING STILL NEEDED

While Singapore's population is increasingly being vaccinated, the need for Covid-19 testing will still continue for the foreseeable future as Singapore further reopens and resumes activities.

PROFESSOR PATRICK TAN, founding programme director of Stronghold Diagnostics Lab and executive director of A*Star's Genome Institute of Singapore.

Deputy Prime Minister Heng Swee Keat (far left) visiting Stronghold Diagnostics Lab on Monday. The laboratory, a Covid-19 testing facility at Biopolis in Buona Vista, was set up to boost national polymerase chain reaction (PCR) testing capabilities, and has been operational since the middle of last year. PHOTO: A*STAR

boost national polymerase chain reaction (PCR) testing capabilities and has been operational since the middle of last year.

It was established by A*Star and the National University Health System (NUHS), with Temasek Foundation as an industry partner.

Professor Patrick Tan, founding programme director of Stronghold and executive director of A*Star's Genome Institute of Singapore, said the lab processes tests from a

wide variety of sources and formats, including from the local community, dormitories and stay-home notices.

"We coordinate closely with the Health Ministry to respond and process samples based on current needs," he added.

Testing for Covid-19 remains an important pillar of Singapore's strategy to control the coronavirus outbreak by preventing the seeding of new clusters.

This is crucial, since people who have been vaccinated against or infected with the virus before can get Covid-19 again.

In February, Singapore's first case of likely Covid-19 reinfection was detected. And on Sunday, a migrant worker who had been vaccinated against Covid-19 was found to have been infected with the coronavirus.

Singapore said last year that it aimed to conduct about 40,000

Covid-19 tests a day, and the latest figures from the Ministry of Health's website showed that as at April 5, the rate stands at about 34,800 tests a day.

"While Singapore's population is increasingly being vaccinated, the need for Covid-19 testing will still continue for the foreseeable future as Singapore further reopens and resumes activities," Prof Tan said.

The lab is manned by more than 150 staff, including volunteer scientists from A*Star and universities, and medical staff from NUHS, as well as fresh graduates and professionals with relevant experience and qualifications.

Prof Tan said: "Besides providing jobs for Singaporeans, Stronghold Diagnostics Lab has also trained many staff in clinical diagnostics, increasing the local pool of skilled qualified staff for future pandemic contingencies. The lab's platforms are adaptable and can be deployed to other screening efforts in the future, including for other infectious diseases."

Mr Philip Lim, programme director of Stronghold and A*Star's chief risk officer, said the need for scale requires the use of automation.

This includes the use of laboratory automation systems such as the Bio Rapid Automated Valence Engine - an A*Star initiative.

The system includes barcode scanning for identification of samples, and custom-made robotic and automation systems for handling of test samples, including capping and uncapping of test tubes, and pipetting and movement of liquids.

A*Star said this helps to minimise human errors and reduce contamination and infection risks for laboratory staff, resulting in accurate, reliable and high-throughput testing processes within a safer environment.

Mr Lim said local small and medium-sized enterprises were involved in the assembly and roll-out of these automation solutions, which have also been delivered to other commercial labs in Singapore.

Yesterday, Mr Heng thanked Singapore's scientific and research community for their efforts, calling them "silent heroes" in the nation's battle against the coronavirus. He said: "They have made a real difference to our pandemic response."

audreyt@sph.com.sg

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Boosting National Capacity for Larger-scale COVID-19 Testing

Alongside vaccinations, testing is a critical pillar of Singapore's multi-pronged strategy against COVID-19. The Stronghold Diagnostics Lab (SDL) was established by A*STAR and the National University Health System (NUHS), with Temasek Foundation as a strategic industry partner. Together with other partner laboratories, SDL works to [boost capacity for larger-scale COVID-19 testing](#) and support Singapore's

resumption of economic activities. SDL's testing facilities integrate A*STAR's capabilities in biomedical sciences and Industry 4.0 technologies such as automation and smart sensing. The lab is manned by a workforce of over 150 staff, consisting of volunteer scientists from A*STAR, the universities and medical staff from NUHS, as well as fresh graduates and professionals with relevant experience and qualifications.

BIOINFORMATICS AND MODELLING STUDIES

Tapping on modelling and simulation to inform public policy in mitigating transmission risks as Singapore reopens its public spaces

Safe Management Measures on Trains

A*STAR worked with the Land Transport Authority (LTA) to [model the dispersion of droplets and aerosols on public transportation](#), and developed recommendations using the findings. The study reinforced the importance of safe management measures such as wearing of masks and avoiding talking on trains.



▲ Experimental design of smoke spread in a moving train cabin.

Mitigating COVID-19 Transmission Risks

Temasek Foundation, A*STAR, and other research partners such as ITE College East and Temasek Life Sciences Laboratory,



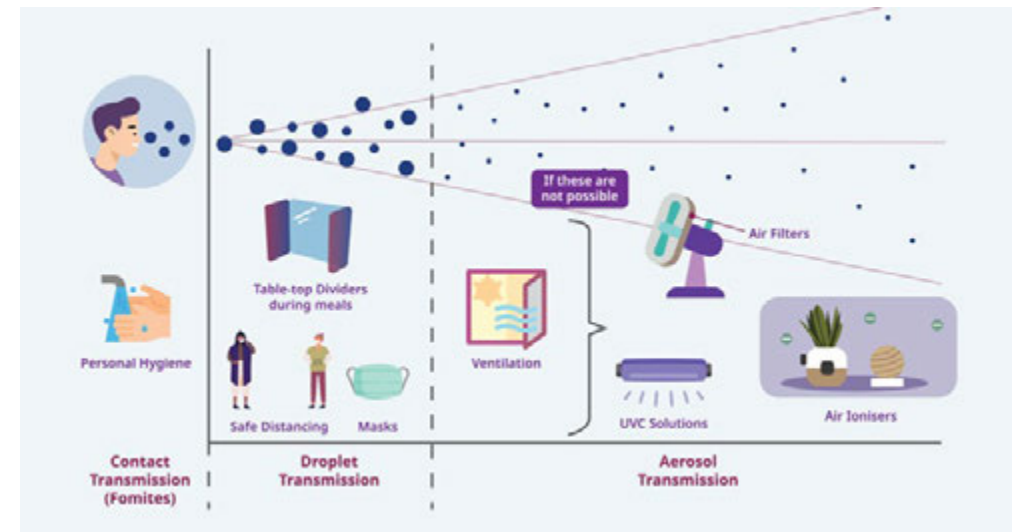
▲ Plant-based ionisers.

conducted extensive scientific studies in collaboration with public agencies to glean [insights on how to further reduce the risk of COVID-19 transmission](#). Results of these studies showed that environmental mitigation measures such as ventilation in spaces, air filters, air ionisers, table-top dividers and UVC lights were effective in reducing transmission risks through fomite, droplet and aerosol routes.

Helping to Design Safe Management Measures

Researchers from A*STAR's Institute of High Performance Computing (IHPC) and Institute of Materials Research and Engineering (IMRE) developed a [computational fluid dynamics framework to accurately model the spread of droplets](#) when a person with

COVID-19 coughs in Singapore's tropical environment. The findings showed that the spread of droplets and aerosols varied greatly depending on environmental conditions. As such, every event venue presents different risk levels and specific safety measures.



▲ Overview of preventive measures to reduce fomites, droplet and aerosol transmission.

PROTECTIVE FACE MASKS

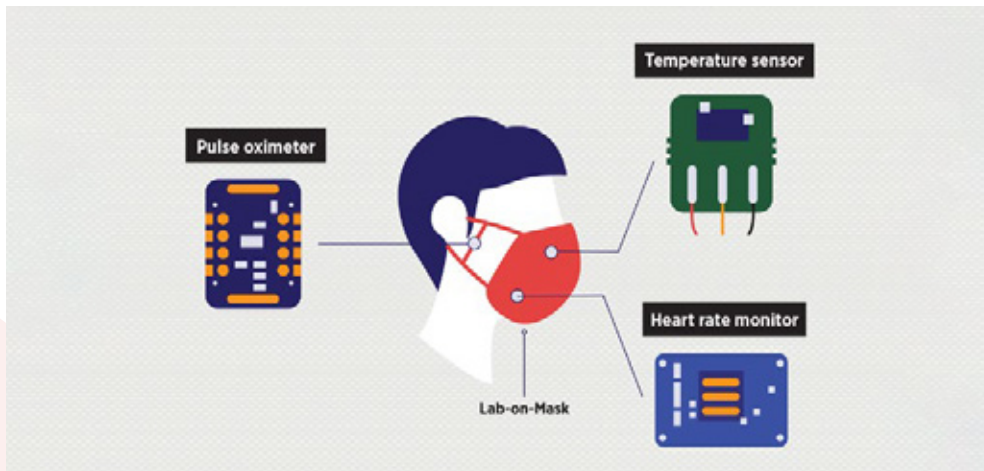
Innovations on the form and function of medical-grade face masks

Integrated Face Mask Health Monitoring System

Researchers from IMRE and Nanyang Technological University (NTU) developed an [integrated monitoring system for face masks to detect health indicators associated with COVID-19](#). The system comprises sensors that monitor a wearer's vital signs, including blood oxygen saturation, blood pressure, heart rate and skin temperature. This innovation can help health care providers remotely monitor the conditions of their patients, as well as reduce the risk of frontline workers being infected.



▲ (From left) Professor Chen Xiaodong from NTU and Professor Loh Xian Jun from IMRE showcasing the smart mask which allows the wearer's real-time data to be transmitted to a smartphone via Bluetooth.

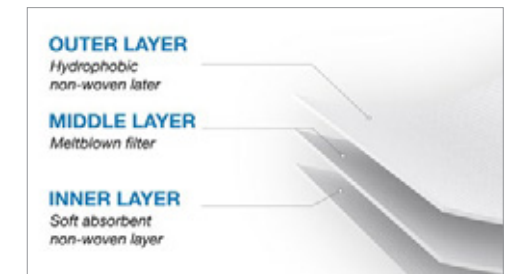


▲ Different sensors like pulse oximeters, temperature sensors and heart rate or blood pressure monitors can be incorporated into the Lab-on-Mask, which is made of flexible polydimethylsiloxane.

Supporting the Production of Medical-grade Masks

During the initial months of the COVID-19 pandemic, researchers from A*STAR's Institute of Chemical Engineering Sciences (ICES) worked with ST Engineering's Innosparks to lay the groundwork for [Singapore to begin producing mask filters](#). Researchers analysed the material properties of melt-blown polypropylene, including fibre diameter, density and porosity, and how they correlated to breathability and filtration efficiency. The results of the analysis helped ST Engineering derive the optimal production parameters for the production of medical-grade masks. Subsequently,

ICES researchers continued to support Innosparks to set up Singapore's first melt-blown non-woven filter production line.



▲ Material layers of a surgical mask.
Source: ST Engineering Innosparks

Innovative Reusable Face Masks

Researchers at A*STAR's Singapore Institute of Manufacturing Technology (SIMTech) and Advanced Remanufacturing and Technology Centre (ARTC) have found a way to make reusable face masks that have the merits of disposable surgical masks, yet are washable like cloth masks. Collaborating with local textile and apparel manufacturer Ramatex, which has deep knowledge in fabrics, the production of these reusable masks ramped up local mask availability and eased demand for surgical masks. Ramatex began production

of these reusable masks in Singapore in April 2020, further contributing to national efforts to combat the transmission of COVID-19.



▲ Ramatex masks in production.

ROBOTICS

Supporting frontline workers through automation

Bio Rapid Automated Valence Engine (BRAVE) 🖱️



▲ Operator from the Stronghold Diagnostics Lab, bringing COVID-19 test samples to BRAVE, an automated system for sample processing using Industry 4.0 technologies such as robotics and smart sensors.

BRAVE is an automated system designed by researchers from A*STAR's Advanced Remanufacturing and Technology Centre (ARTC), Singapore Institute of Manufacturing Technology (SIMTech), and DxD Hub, in collaboration with local enterprise KA Industrial Engineering.

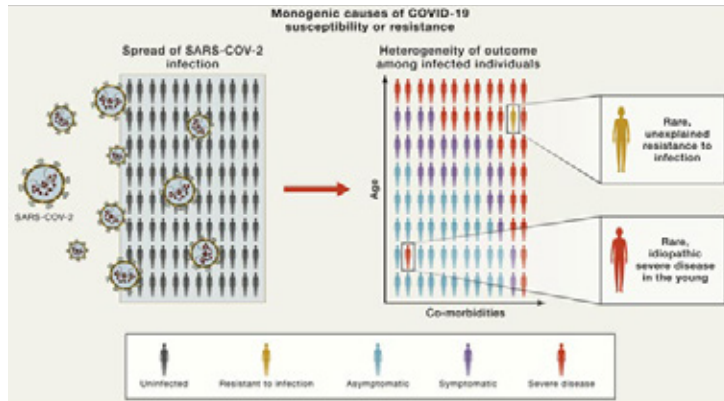
BRAVE supports the nation's goal of larger-scale COVID-19 testing through capabilities such as

barcode scanning for sample identification, and customised robotic systems for automated handling of test samples. BRAVE helps minimise human errors as well as contamination and infection risks for laboratory staff, resulting in accurate, reliable and high-throughput testing within a safer environment.



COVID-19 RELATED RESEARCH PAPERS

Contributing to the understanding of the virus and its effects on society



▲ Monogenic causes of susceptibility or resistance to SARS-CoV-2 infection.

Unravelling the Mystery of COVID-19 Infections

Our researchers contributed to the “COVID Human Genetic Effort”, an international genetics consortium seeking to discover why COVID-19 infections are silent in some cases and lethal in others.

Lisa Ng,
Singapore Immunology Network (SIgN)

Laurent Rénia,
Infectious Diseases Labs (ID Labs)

[A Global Effort to Define the Human Genetics of Protective Immunity to SARS-CoV-2 Infection](#)

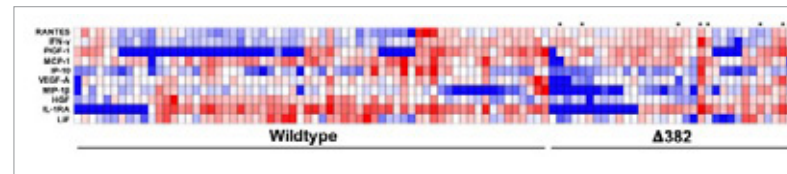
Cell

Discovering a Mutation with Milder Outcomes for COVID-19 patients

A*STAR’s scientists and collaborators from the National Centre for Infectious Diseases, the Ministry of Health, Duke-NUS Medical School, A*STAR’s Infectious Diseases Horizontal Technology Programme Office and BII detected a mutation in SARS-CoV-2 called $\Delta 382$, which presents milder clinical outcomes.

Lisa Ng, SIgN

[Effects of a Major Deletion in the SARS-CoV-2 Genome on the Severity of Infection and the Inflammatory Response: An Observational Cohort Study](#)
The Lancet



◀ Patients infected with $\Delta 382$ variants had milder infection with less systemic release of proinflammatory cytokines, chemokines, and growth factors that are strongly associated with severe COVID-19.

Identifying SARS-CoV-2 Spike Protein that Elicits Neutralising Antibodies

Together with the local R&D ecosystem, our scientists identified immunogenic targets against the coronavirus spike glycoprotein to provide crucial advances towards the development of diagnostic tools and potential vaccine candidate targets.

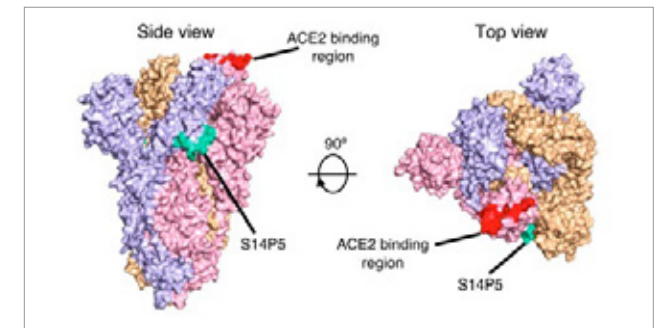
Lisa Ng, SIgN

Laurent Rénia, ID Labs

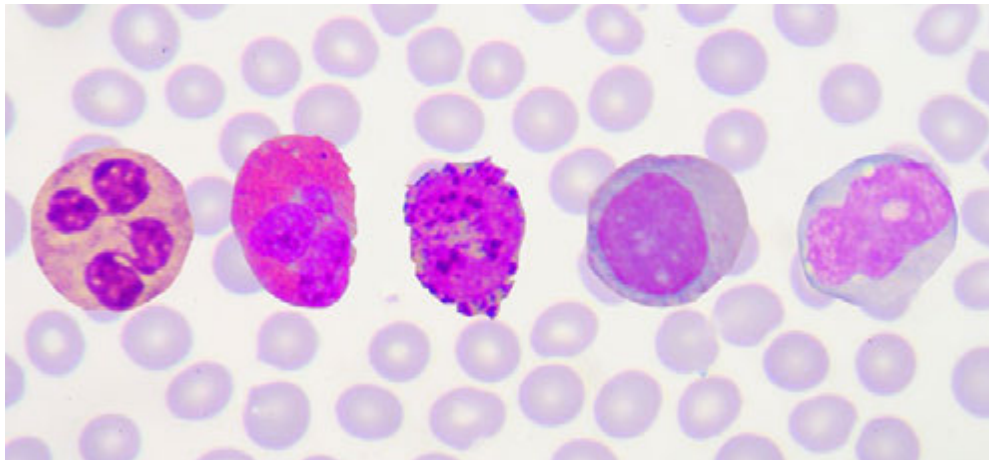
Wang Cheng-I, SIgN

[Two linear epitopes on the SARS-CoV-2 spike protein that elicit neutralising antibodies in COVID-19 patients](#)

Nature Communications



▲ Antibodies against S14P5 and S21P2 linear B-cell epitopes neutralise SARS-CoV-2.



Predicting Risk and Severity of COVID-19 through Blood Markers

Our researchers, together with international collaborators, identified biomarkers and cellular markers which could predict the risk or severity of COVID-19 in patients. This finding could lead to new therapeutic avenues for the treatment of COVID-19, as well as a kit that predicts the severity of the disease in patients.

Florent Ginhoux, SgN
[Elevated Calprotectin and Abnormal Myeloid Cell Subsets Discriminate Severe from Mild COVID-19](#)
 Cell

The Effectiveness of Sanitising Agents

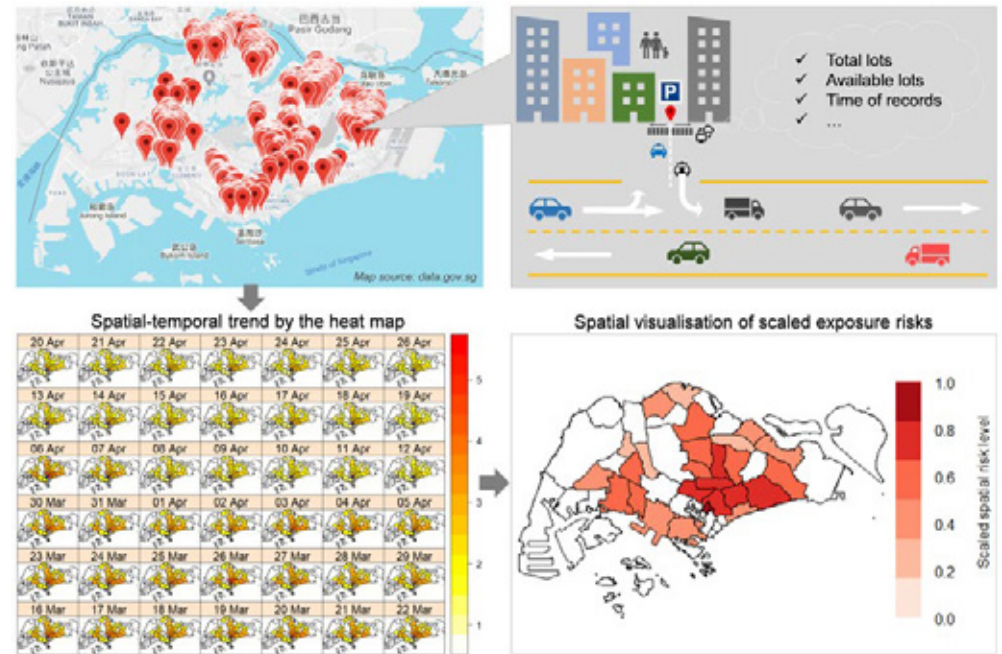
Scientists from A*STAR reviewed commercially available disinfectants to evaluate their effectiveness to inactivate viruses, such as COVID-19, under various conditions.

Loh Xian Jun and Jason Lim, IMRE
[Sanitizing Agents for Virus Inactivation and Disinfection](#)
 View

Singapore's Lockdown Measures and its Effects on COVID-19 Exposure Risk

With collaborators from Delft University, Brno University of Technology and MOH, our scientists studied how measures curbing mobility affected COVID-19 exposure risk and air quality.

Fu Xiuju and Jiang Peng, IHPC
[Spatial-temporal Potential Exposure Risk Analytics and Urban Sustainability Impacts Related to COVID-19 Mitigation: A Perspective from Car Mobility Behavior](#)
 Journal of Cleaner Production

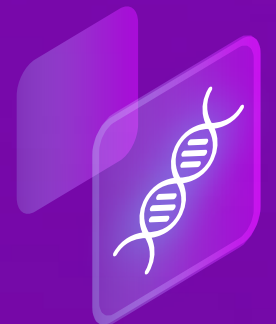


▲ Workflow from car park activity to mobility-based exposure risk.



Contributing to Better Health Outcomes for Singapore

A*STAR works closely together with the clinical community, public sector and industry to develop innovative healthcare solutions that improve health outcomes for Singaporeans. Our goal is to build robust systems for the prevention, diagnosis and treatment of diseases to keep our population healthier for longer.



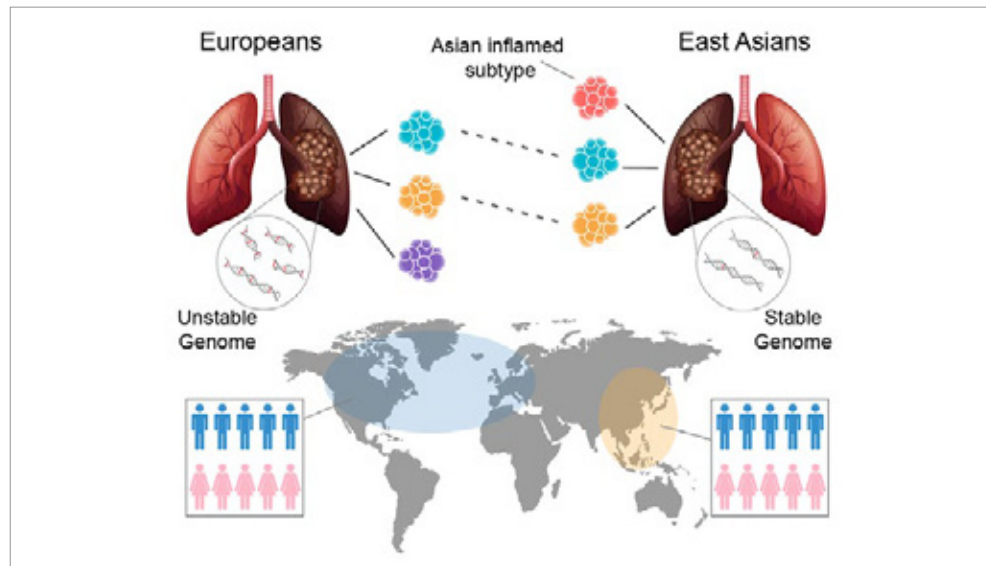
◀ *Researcher measuring baby's body composition using a machine.*

DISCOVERING TARGETED THERAPIES FOR CANCER

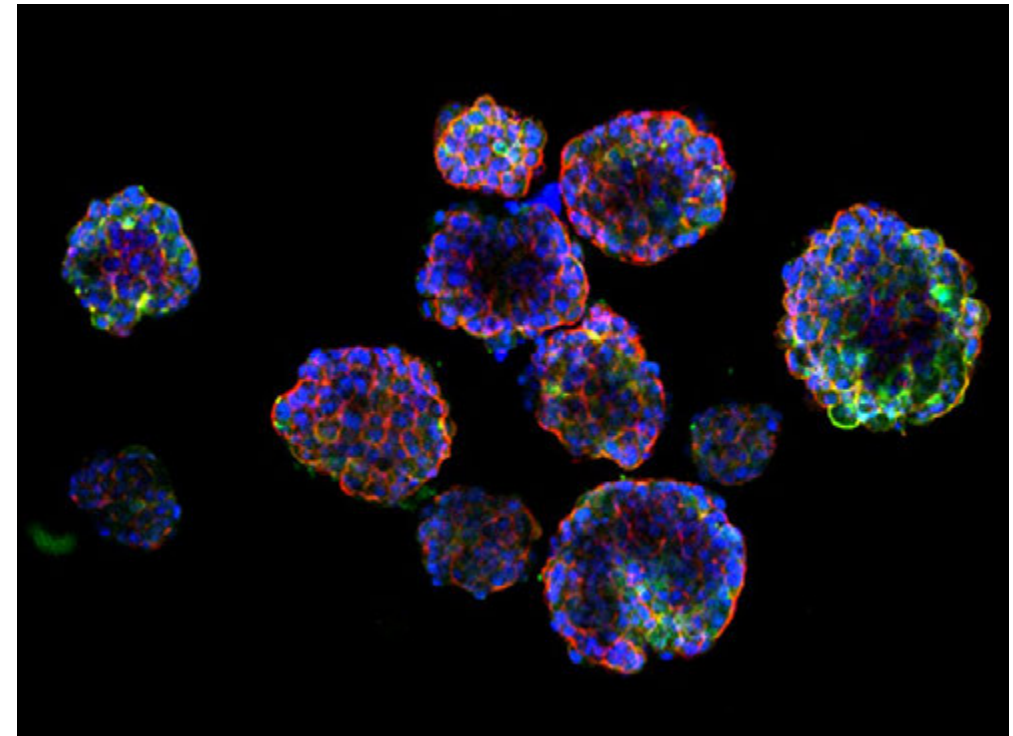
Discovering an Asian-specific Lung Cancer ✎

Scientists from A*STAR's Genome Institute of Singapore (GIS), in collaboration with the National Cancer Centre Singapore, and the Lung Cancer Consortium Singapore have completed one of the largest comprehensive genome studies of Asian lung adenocarcinoma (LUAD). The study revealed that a unique sub-group of lung tumours, which contain high

amounts of immune cells, appear to be more inflammatory in Asian patients than European patients. Findings from this landmark study, which was published in [Nature Genetics](#), ✎ will deepen researchers' and clinicians' understanding of individual patient's response to drug treatments, thereby enabling a more precise approach to future treatment.



▲ LUAD in East Asians show a novel inflamed sub-type and more stable genomes compared with those in Europeans.



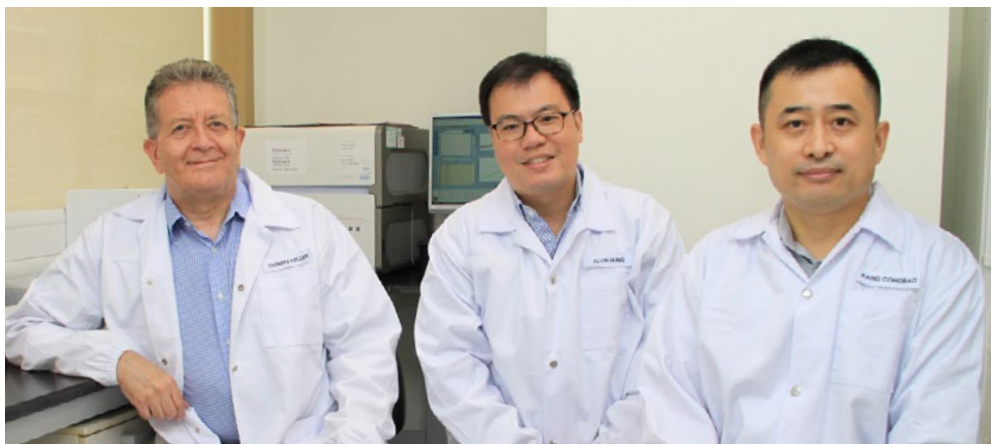
▲ Fluorescence staining of the epithelial markers of the NPC organoids.

More Accurate Treatment for Nasopharyngeal Cancer

A*STAR's Institute of Bioengineering and Nanotechnology (IBN) and the Singapore Institute of Advanced Medicine Holdings have created the [first of its kind in-vitro patient-derived 3D organoid models](#)

[of Nasopharyngeal Cancer \(NPC\)](#). ✎ Compared to current treatment methods, where cases can recur due to insufficient radiation, these models offer a better guide for radiation dosing.

SUPPORTING THE LOCAL DRUG DEVELOPMENT ECOSYSTEM



▲ The founders of Ligature Therapeutics: (from left) Dr Thomas Keller, Dr Alvin Hung and Dr Congbao Kang.

“ The technology licensed from A*STAR will enable Ligature Therapeutics to rationally design small molecule drugs to address previously intractable diseases. ”

– Dr Alvin Hung
Co-founder of Ligature Therapeutics

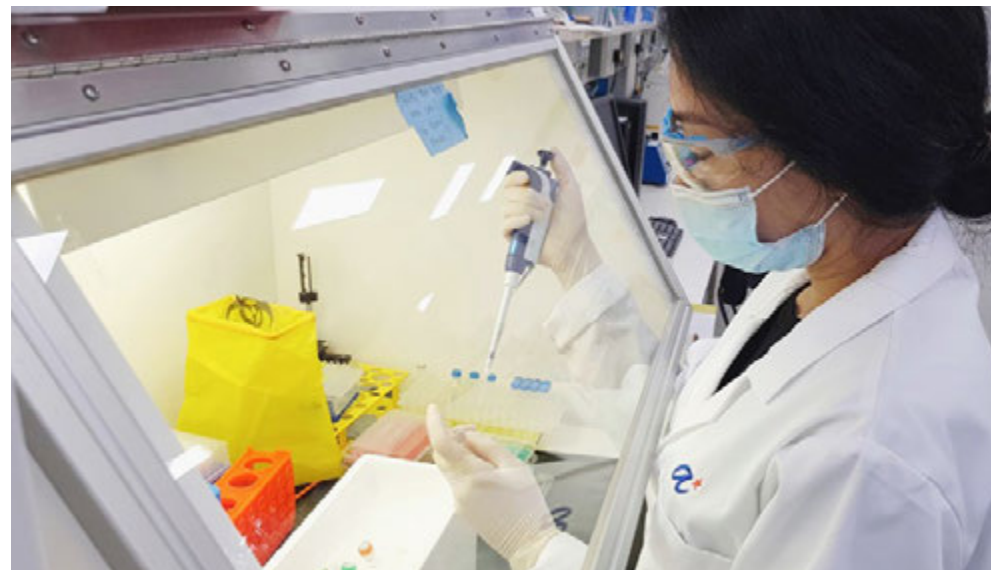
Spin-off Company to Focus on Designing Small Molecule Drugs

A*STAR's Experimental Drug Development Centre (EDDC), a national platform for drug discovery and development, [launched its first spin-off – Ligature Therapeutics](#). The early-stage drug discovery company will build on technologies proprietary to EDDC to design small molecule drugs for patients.

New Milestone for Singapore-made Cancer Drug – ETC-159

[ETC-159 has achieved a new developmental milestone in Phase 1B](#) with the first dose being administered to patients. In this new phase of clinical testing, scientists will look at efficacy as well as safety of this cancer drug.

ETC-159, which was developed in EDDC, targets a range of cancers including colorectal, endometrial, ovarian and pancreatic cancers, which contribute to a significant fraction of Singapore's cancer burden.



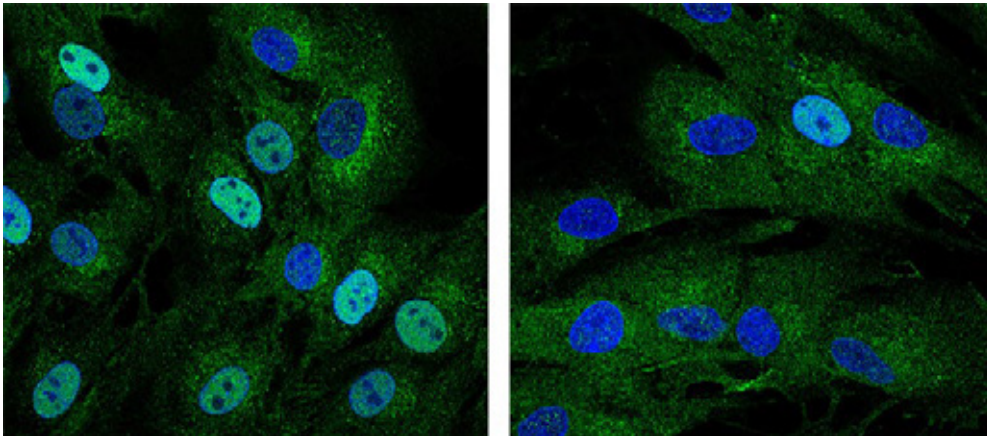
▲ Scientists from EDDC, A*STAR, preparing ETC-159 clinical samples for real-time Reverse Transcription-Polymerase Chain Reaction which amplifies the genetic material.

DRIVING RESEARCH IN PRENATAL AND EARLY CHILDHOOD DEVELOPMENT

Discovery of New Immune Pathway

Scientists from A*STAR's Institute of Molecular and Cell Biology (IMCB), in collaboration with doctors from KK Women's and Children's Hospital (KKH), have discovered a [new immune pathway while investigating how a novel mutation](#)

[in the NFKBIA gene could cause severe immunodeficiency.](#) These findings were [published in The Journal of Clinical Investigation](#) and have implications for the development of treatments against liver disease and cancer.



▲ Staining for the signalling protein NFκB (green) in skin cells from a healthy individual (left) and the patient (right) after immune stimulation. The patient's novel NFKBIA variant impairs entry of NFκB into nucleus (blue). This defect led to changes in cytokine production, resulting in both immunodeficiency and multi-organ damage.



▲ Dr Florent Ginhoux, Senior Principal Investigator at A*STAR's SigN, and senior co-author of the study.

How Allergies are Passed on in the Womb

In a [collaborative study](#) by A*STAR's Singapore Immunology Network (SigN), KKH and Duke-NUS Medical School in Singapore, researchers discovered that [mothers pass on allergies to](#)

[offspring while they are still developing in the womb.](#) This finding hints at why infants exhibit allergies so early in life and suggests possible targets for intervention.

Growing Up in Singapore Towards Healthy Outcomes (GUSTO)



▲ GUSTO has yielded 279 published papers to date and its findings have impacted national health policy.


Since 2009, GUSTO (Growing Up in Singapore Towards Healthy Outcomes) researchers have published many pertinent findings revealing how conditions in pregnancy and early childhood influence the subsequent health and development of mothers and their children. The latest findings offered insights into how adjustments to lifestyle habits can lead to better health outcomes. For instance, when


pregnant mothers get better sleep, their risk of getting gestational diabetes mellitus, or GDM, is reduced.

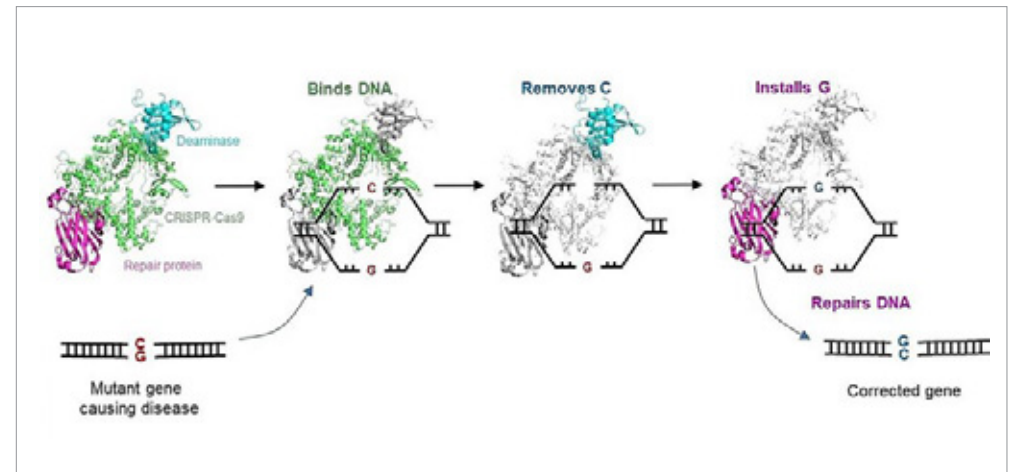
Another observation of note is that young children who eat when they are not hungry, are more likely to continue doing so when they are older, and also tend to select larger portions of food. This can lead to a higher body weight when they become adults.

SUPPORTING GENE-EDITING THERAPY

Enabling Treatment for Genetic Diseases

A team of researchers from GIS developed a CRISPR-based gene editor, [C-to-G Base Editor \(CGBE\)](#), to correct mutations that cause genetic disorders.  This invention opens up treatment options for

human diseases such as cystic fibrosis, cardiovascular diseases, musculoskeletal diseases and neurological disorders. This research has been published in [Nature Communications](#). 



▲ The C-to-G base editor (CGBE) converts C in genes to G. This invention corrects disease-causing mutations into healthy versions, enabling treatment for genetic diseases.



Enabling the Local Industry to Emerge Stronger

Through our applied and translational research, A*STAR contributes actively to the digitalisation and innovation journey of our local enterprises, so that they can emerge stronger from this crisis. We aim to keep the local industry globally competitive with cutting-edge products and services in high-value industries.



◀ A*STAR's Model Factory initiative allows companies to learn from, and test newer Industry 4.0 technologies.

STRENGTHENING CAPACITY OF LOCAL COMPANIES FOR MARKET-ORIENTED INNOVATION



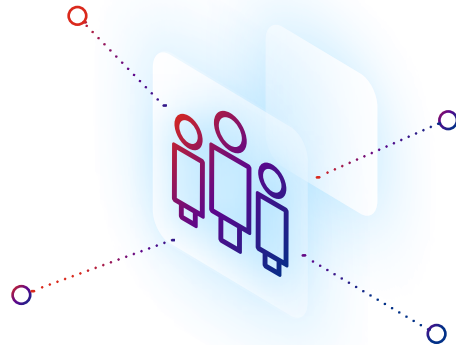
T-Up Builds SMEs' Technological Capabilities

The T-Up scheme helps SMEs looking to expand in-house R&D and technical capabilities, accelerate new products and processes, and set up technical departments by attaching our A*STAR scientists and research engineers to them for a period of up to two years.

Since T-Up's inception in 2003, more than

900 researchers

have been seconded to over **800** local SMEs



Champs Industrial

One SME that has benefitted from A*STAR's T-Up programme is Champs Industrial. Since 2017, two A*STAR researchers have been seconded to the company to support the development

of a first-of-its-kind ultraviolet-C (UV-C) disinfection water heaters in 2019. Champs has filed **three patents** relating to the UV-C disinfection technology.



Innovating with the Model Factory

The Model Factory helps companies co-develop and testbed Industry 4.0 technologies to become more competitive. The initiative is hosted by the Advanced Remanufacturing and Technology Centre (ARTC) and the Singapore Institute of Manufacturing Technology (SIMTech).

Since its launch in 2017,

around **130** companies

have participated in the Model Factory Initiative including local SMEs Arcstone and Abrasive Engineering



Innovation Factory Brings Commercially Viable Products to Life

A*STAR and Enterprise Singapore's pilot Innovation Factory @ SIMTech was launched in December 2020 to help local SMEs transform ideas into commercially viable products that are ready for market adoption. A full-scale version is slated to open at CleanTech Park by early 2022. Strategic partners of the programme include the Singapore Precision Engineering & Technology Association, and the Singapore Manufacturing Federation.



▲ Second Minister for Trade and Industry, Dr Tan See Leng (centre) officiated the launch of the Pilot Innovation Factory at SIMTech on 15 December 2020.

“ I am very happy to know that our local SMEs are looking ahead by continuing to invest in R&D during these challenging times. ”

— Dr Tan See Leng
Second Minister for Trade and Industry

To date, **20** local SMEs have joined Innovation Factory @ SIMTech & More than **10** projects to co-create products have been kicked off

JM VisTec System

Local SME, JM VisTec System, engaged the Innovation Factory to develop a structured-light 3D scanner for their machine vision solution. Through this initiative, the company is currently in the process of commercialising the scanner and rolling it out to a range of industries, including logistics, defence, healthcare, agri-technology and construction.



▲ JM VisTec System's 3D Fringe Projection Scanner

A*STAR's Future of Manufacturing Initiative

Bolstering the competitiveness of the local manufacturing sector by helping companies build advanced manufacturing capabilities.

PD Solutions

ARTC partnered local SME PD Solutions to develop an automated production scheduling solution for liquid concentrates. This innovation has since been adopted by a beverage company, where scheduling of the production of liquid concentrates is a critical step in its production process. Thus, PD Solutions moved up the value chain — from software supplier to innovator.



▲ PD Solutions' automated production scheduling solution for liquid concentrates.



Second Minister for Trade and Industry Tan See Leng (right) with Mr Marcus Sia, managing director of surface finishing firm ATC, at A*Star's pilot Innovation Factory @ SIMTech yesterday. ATC is among 14 firms that have joined the innovation factory to co-create products with the Singapore Institute of Manufacturing Technology (SIMTech). ST PHOTO: KHALID BABA

A*Star sets up joint labs with two SMEs to build new capabilities

Prisca Ang

The Agency for Science, Technology and Research (A*Star) has set up laboratories with two local small and medium-sized enterprises, to the tune of \$15.5 million, to help these firms build new capabilities.

A*Star's Advanced Remanufacturing and Technology Centre (ARTC) will have a new joint lab with Tru-Marine, which specialises in maintenance, repair and overhaul of turbochargers.

Their combined investment will be \$6 million over three years, and they will develop a new system to monitor the health of marine turbochargers in real time. This allows predictive maintenance and helps ship owners, managers or operators save costs and avoid unplanned downtime.

Mr James Loke, group chief executive of Tru-Marine, said: "While we have the idea, it might take us a longer time to develop it because of the (limited) resources of an SME. With ARTC's strong support and domain expertise on how data is being transferred, this will greatly

help us reduce the timeline of our product going into the market."

The firm will pilot the service on Pacific International Lines' ships. Tru-Marine has hired a data analyst and a data scientist, and will recruit three or four more in similar roles in the next few years.

Meanwhile, ARTC and Abrasive Engineering (AE) will invest a total of \$5.5 million over three years in a joint lab that will help AE build advanced manufacturing capabilities and enter new industries.

In the pipeline are higher precision valves for more industries, including additive manufacturing and fast-moving consumer goods, as well as a fully automated room for sandblasting.

The joint lab will create at least nine new jobs in production and engineering roles.

It will also tap the expertise of scientists and engineers from two other A*Star units: the Institute of High Performance Computing and the National Metrology Centre.

A*Star yesterday also launched its pilot Innovation Factory @ SIMTech (Singapore Institute of Manufacturing Technology), in collaboration with Enterprise Singapore. At the 1,400 sq ft co-creation

space, A*Star scientists and engineers will guide companies to design and create new products.

The factory's facilities include a workshop with electrical and mechanical design tools, and manufacturing equipment like 3D printers.

Once a company is ready to scale up production for a newly developed product, it can move to the Model Factory @ A*Star to make it.

A full-scale version of the innovation factory is expected to open next year at the CleanTech Park in the Jurong Innovation District, spanning 5,000 sq ft to 6,000 sq ft.

Fourteen local SMEs and two trade associations have joined the pilot factory as members and strategic partners, respectively.

Second Minister for Trade and Industry Tan See Leng, who was at the launch of the joint labs and innovation factory, said he was "very happy to know that our local SMEs are not standing still and waiting for the (pandemic) to blow over".

"I encourage other SMEs to also develop new business lines and strengthen their existing ones, to increase revenue, profits and strengthen their competitive advantages."

prisang@sph.com.sg


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Tru-Marine and Abrasive Engineering

In December 2020, A*STAR launched two R&D joint laboratories with local SMEs — Tru-Marine and Abrasive Engineering. Members of ARTC since 2013, the two companies are working with A*STAR

to build capabilities in digitalisation and develop new business models, plus new products such as a monitoring system for marine turbochargers and higher precision valves.

Advanced Manufacturing Training Academy (AMTA)

Launched in October 2020, [AMTA](#)  seeks to enhance the competitiveness of Singapore's manufacturing sector through continuous training, upskilling and reskilling. AMTA's strategy includes identifying emerging skills and knowledge required for Industry 4.0, and creating a

curriculum to train workers for Singapore's manufacturing industry. This initiative is supported by A*STAR, the Singapore Economic Development Board (EDB), Enterprise Singapore (ESG), Nanyang Technological University (NTU Singapore) and SkillsFuture Singapore (SSG).



▲ (From left) Prof Tan Sze Wee, Assistant Chief Executive, Enterprise, A*STAR; Mr Lee Kok Choy, Chairman, AMTA Training Council; Mr Lim Kok Kiang, Executive Vice President, EDB; Deputy Prime Minister, Coordinating Minister for Economic Policies and Minister for Finance Mr Heng Swee Keat; Mr Michael Fung, Deputy Chief Executive, SSG; Prof Ling San, Provost, NTU Singapore; Mr Ted Tan, Deputy Chief Executive, ESG.

New training office to design courses that help workers excel

To bolster the competitiveness of Singapore's manufacturing sector, a new industry-led training programme office will plan ways to ensure the workforce has emerging know-how.

Launched yesterday, the Advanced Manufacturing Training Academy (AMTA) will be located at the Jurong Innovation District (JID) manufacturing hub, which has attracted about \$420 million in investments over the past year.

The AMTA programme office will work with schools and training providers to design new courses to help workers excel, as Singapore establishes itself as an advanced manufacturing hub. It will also work to predict what skills and knowledge such workers will need to meet future



An artist's impression of the Jurong Innovation District manufacturing hub, the first phase of which is expected to be completed around 2022. The Advanced Manufacturing Training Academy, to be located in the district, will work with schools and training providers to design courses for workers. PHOTO: JTC

Source: The Straits Times © Singapore Press Holdings Limited. Permission required for reproduction.

Operation & Technology Roadmap (OTR)

Through OTR, A*STAR helps local enterprises develop customised roadmaps that are aligned to their business strategies and goals. So far, we have supported NTUC's efforts to upskill workers by transferring know-how, and training more than 30 facilitators from their Training and Transformation team.



Supporting Internationalisation through A*STAR Partners' Centre (A*PC)

Launched in November 2020, A*PC aims to [support Singapore companies' internationalisation efforts in China's Suzhou Industrial Park.](#)  It backs regional-ready enterprises as they embark on R&D, commercialisation and expansion efforts in Jiangsu and the greater Yangtze River

Delta region. Specifically, A*PC helps companies to leverage A*STAR's bilateral networks, scientific expertise, facilities and laboratories, to co-develop and commercialise technologies in areas such as biomedical sciences, nanotechnology and advanced manufacturing.

More information: [MTI Budget Booklet](#) 



▲ A*STAR Partners' Centre, Suzhou.

Supporting Singapore-based Enterprises' Innovation Journey

Smart Shipyard to Improve Productivity and Personnel Safety

In November 2020, A*STAR and ST Engineering Marine Ltd (STEML) embarked on a collaboration to develop and deploy pervasive and secure wireless connectivity technologies in shipyards. These technologies could potentially support STEML's deployment of future Industrial Internet of Things and Smart Yard applications, such as autonomous

guided vehicles, localisation and tracking of STEML's assets and personnel, and preventive maintenance of its key assets and machinery. The three-year project, which taps on A*STAR's Institute for Infocomm Research (I²R)'s expertise in communications and networks, is an important step in STEML's digital transformation plans to improve productivity and personnel safety.



Advancing Innovations in Coating Technologies

A*STAR and NIPSEA Technologies, a research and development arm of Nippon Paint Group, have collaborated to develop coating solutions for the built environment to be more “visible” to autonomous vehicles. This project leverages A*STAR ICES' coatings technology, and I²R's capabilities in machine learning, autonomous

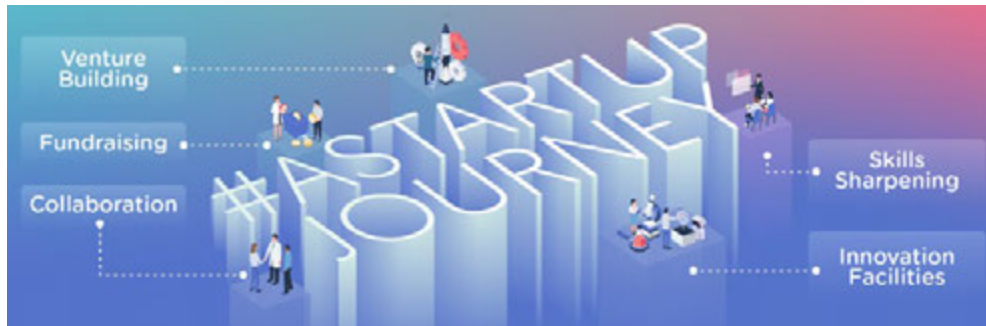
perception and visual intelligence, to develop solutions that address the key challenges of safety, reliability and cost in autonomous driving. This collaboration builds upon a long-standing partnership that started in 2012 – to advance innovations in coating solutions for food and medicine packaging.



▲ (From left) Mr Wang Chyang, Managing Director of Nippon Paint Singapore Group; Mr Wee Siew Kim, Group Chief Executive Officer of NIPSEA Group; Mr Frederick Chew, Chief Executive Officer of A*STAR, and Prof Tan Sze Wee, Assistant Chief Executive, Enterprise, A*STAR.

CONTRIBUTING TO A VIBRANT LOCAL START-UP ECOSYSTEM

Incubating Start-ups for Success



Since September 2016, A*STAR and A*StartCentral (ASC) have supported more than 220 deep tech start-ups to incubate and accelerate their growth through programmes and resources such as our

life sciences and engineering labs. We have also helped to foster engagement between researchers, industry, investors and entrepreneurs.

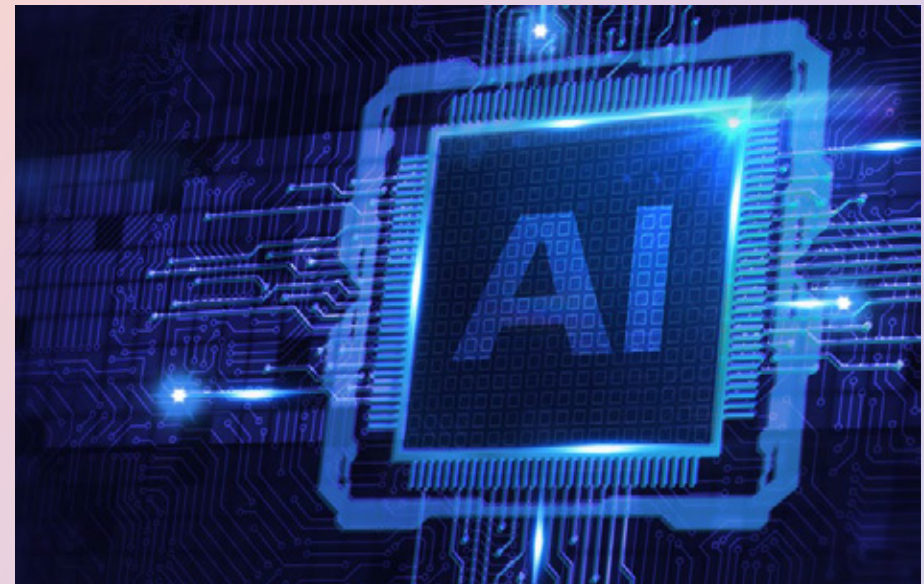
Start-ups supported by
A*STAR attracted

>\$300M

of follow-on funding in
Research, Innovation and
Enterprise (RIE) 2020



A*StartCentral Success Stories



A*STAR's technologies provide deep-tech start-ups with competitive differentiation, while ASC's programmes help accelerate the start-up journey.

Local start-up Sentient.io, for example, benefited by licensing A*STAR technologies for its AI-as-a-service

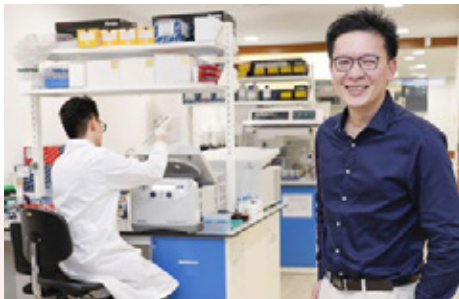
business model. They then went on to raise US\$5 million (S\$6.8 million), which included investments from ABC Dream Ventures and Digital Garage Group. Other start-ups incubated at ASC include Engine Bio, Tychan and Krosslinker.

NURTURING MORE THAN HALF OF SINGAPORE'S BIOTECH START-UPS

A*STAR plays a significant role in the local biotech and medtech ecosystem by nurturing start-ups that maximise value from biomedical sciences research. Today, around half of all biotech start-ups in Singapore are in partnership with us, while a third are A*STAR spin-offs.

Lucence

In April 2020, A*STAR established a joint project with Lucence to develop a proprietary platform for vaccine identification and screening in cancer patients. This follows a [successful Series A funding round](#) that saw the company, which specialises in providing liquid biopsy technology to patients across Asia and North America, raise US\$20 million (S\$27 million).



▲ Lucence founder Tan Min-Han said that the fresh capital will enable the startup to provide its liquid biopsy technology to more patients across Asia and North America.

Source: The Business Times © Singapore Press Holdings Limited. Permission required for reproduction.

ImmunoScape

Another spin-off from A*STAR's Singapore Immunology Network (SiGN), [ImmunoScape uses core immune profiling technology licensed from A*STAR](#) to analyse the body's immune responses to

the COVID-19 virus. The company raised US\$11 million (S\$15 million), allowing it to expand its operations and enhance its technology in immune profiling.

Local biotech firm doing Covid-19 research gets \$15m fund injection

Sum will boost its immune profiling tech that is key to developing vaccines and treatment

Clara Chong

A local biotechnology firm involved in Covid-19 research has raised US\$11 million (S\$15 million) from international investors to expand its operations and enhance its technology in immune profiling.

The significant fund injection will support the multiple projects that ImmunoScape, a spin-off from the Agency for Science, Technology and Research (A*Star) which started operations in 2017, is working on.

A key project is partnering vaccine development firms and research groups to analyse the body's immune responses to the coronavirus. ImmunoScape is also doing research in immune-oncology, aimed at developing treatments that use the body's immune system to fight cancer.

The two main investors are US-based venture firm Anzu Partners, which invested US\$6 million, and the University of Tokyo Edge Capital (Utec) in Japan, which invested US\$2.65 million. Other investors contributed the remaining sum.

Dr Alessandro Nardin, chief operating officer of ImmunoScape, said the team has developed an immune profiling platform that could be leveraged for vaccine design.

Working with Covid-19 patients and recovered individuals, the firm is gathering a large data set on the human T cell response to the virus. The T cell is a type of white blood cell that makes up part of an immune response. The aim is to develop treatment and vaccines with its partners, Dr Nardin said.

ImmunoScape has links with Massachusetts General Hospital in the United States, the University of

"We are expanding into key markets like the US and Japan, building a business development team, as well as a lab in the US," he said.

Mr Ng hopes to eventually be able to use machine learning and artificial intelligence (AI) capabilities to uncover more insights into the immune system.

As more data is collected over time, AI is needed to analyse and process the data to decipher more patterns that might emerge, he said.

This will aid ImmunoScape's current partnerships with drug development companies to develop their cancer and Covid-19 drugs more quickly and increase the success rates of clinical trials.

ImmunoScape also hopes to continue its core work. Enabling advanced immunotherapies for cancer. By analysing every patient's unique immune system, it would help the biopharmaceutical sector to develop individualised medicine for cancer.

This is something Anzu Partners is keen to support, said its managing partner David Michael.

ImmunoScape's success in securing critical funding came after A*Star, introduced the company to Utec and Anzu Partners during a visit to Singapore by the two venture capital firms.

Anzu Partners, which is investing in ImmunoScape for the first time, believes the company has developed available and differentiated capabilities of profiling the immune system.

"We expect the company management to wisely use the funds to develop their commercial capabilities into global biopharma markets," said Mr Michael.

Utec, on the other hand, has previ-



ImmunoScape's operations and development team at its laboratory in Biopolis. The \$15 million fund injection will support the company's multiple projects, a key one being partnering vaccine development firms and research groups to analyse the body's immune responses to the coronavirus. PHOTOS: IMMUNOSCAPE



How T cells fight viruses

When the body is under threat, cells are activated to launch a counterattack. Clara Chong looks at the science behind it.

1 When a virus infects a cell, the cell is altered. The virus then replicates inside the



Singapore Biodesign (SB)

SB is a national talent development and innovation platform that trains and nurtures the next generation of medtech innovators to deliver greater economic value and healthcare impact. To date, SB has trained more than 795 researchers from Singapore and Asia, who have gone on to become company founders, project managers and clinician innovators.

In FY2020, the SB project has supported more than

29 projects

which have raised **>\$18M**

of private and public sector funding

Source: The Straits Times © Singapore Press Holdings Limited. Permission required for reproduction.



Anchoring R&D Investments in Singapore

Singapore's long-term investments in R&D have been a game-changer for our economy and society, from adding value to our thriving biotech start-up ecosystem to anchoring MNCs on our shores.



◀ A*STAR's Model Factory is located within the Jurong Innovation District, Singapore's advanced manufacturing hub developed by JTC.

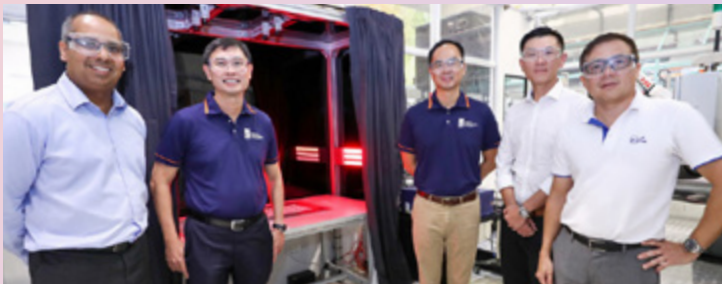
Source: JTC

ADDING VALUE TO SINGAPORE'S ECONOMY

Creating innovative products and services with industry

Rolls-Royce

The Smart Manufacturing Joint Lab between A*STAR, Rolls-Royce and Singapore Aero Engine Services Pte Ltd (SAESL) was first established in September 2017 to accelerate the development of solutions for automatic, digital, adaptive manufacturing and repair for the aerospace industry.



▲ (From left) Rolls-Royce's Dr Bicky Bhangu; A*STAR's Professor Tan Sze Wee; ARTC's Dr David Low; Sysmatic Global's Mr Gavin New; and Zincode Technologies' Mr David Tan.

Source: The Business Times © Singapore Press Holdings Limited. Permission required for reproduction.

Examples of innovative products that have come out of this joint lab include:

- An automated boron nitride spray process developed for Rolls-Royce's Seletar facility, which has been deployed by local SME KA Industrial Engineering
- A new technology that automates part of an inspection process in jet engine manufacturing. Local system integrators Zincode Technologies and Sysmatic Global worked together with us on the solution, which uses an array of cameras and specialised lighting to capture detailed images of jet engine fan blades

Since 2017, the joint lab has seen nearly **30 R&D projects** from

around **100** companies

more than

40

of which are local

In June 2019, A*STAR and Rolls-Royce invested

\$8M

into the joint lab with SAESL,

bringing the total investment of the 5-year collaboration to

\$69M

STMicroelectronics

A*STAR collaborated with European MNC STMicroelectronics and Japanese manufacturer ULVAC to establish the world's first "Lab-in-Fab" in Singapore. The purpose of this partnership was to advance the use of:

- High-value piezoelectric microelectromechanical systems in new applications such as smart glasses, augmented-reality headsets, and automotive light detection and ranging systems;
- Piezoelectric micro-machined ultrasonic transducers for emerging medical applications; and
- Piezo heads for commercial and industrial 3D Printing.

The joint lab draws upon the three partners' complementary expertise to accelerate product innovation and scale up production.



Source: STMicroelectronics

Applied Materials (AMAT)

In 2011, A*STAR's Institute of Microelectronics (IME) and AMAT jointly set up a Centre of Excellence in Advanced Packaging in Singapore. Since then, this advanced packaging collaboration

has helped build Singapore's globally competitive advanced packaging capabilities, created new jobs and developed the local ecosystem.



▲ The world-class facility at Singapore's Science Park II features a 14,000 square foot cleanroom with state-of-the-art semiconductor process equipment custom designed and built by AMAT.

Source: AMAT

Highlights:

- This first-of-its-kind joint lab introduced new capabilities in 3D chip packaging, a critical growth area for the semiconductor industry that will enable the production of smaller and more powerful mobile devices
- In 2016, IME and AMAT extended their research collaboration for five years to focus on advancing key innovations in Fan-Out Wafer-Level Packaging (FOWLPL)
- Between 2011 and 2021, the joint lab created over 100 high-value R&D jobs for researchers, scientists and engineers
- Currently, AMAT engages with more than 30 local enterprises in areas such as metrology, machining and fabrication

Perfect Day

In December 2020, A*STAR and US alternative proteins company Perfect Day signed an agreement to establish an agri-food tech R&D lab for novel foods in Singapore. ✨ The lab will tap on A*STAR's capabilities in taste analysis and protein studies to ensure the accuracy, specificity and consistency of the firm's processes and products such as plant-based ice-cream and cheese. Perfect Day will also help to develop local R&D talent by hiring, training and exposing them to the high-value alternative proteins industry.



US firm, A*Star to open Singapore R&D lab in April

Source: The Straits Times © Singapore Press Holdings Limited. Permission required for reproduction.



▲ (From left) Perfect Day co-founder Perumal Gandhi, Trade and Industry Minister Chan Chun Sing and A*STAR assistant chief executive Ng Huck Hui, BMRC, at the signing of an agreement to establish an agri-food tech R&D lab.


Pinduoduo

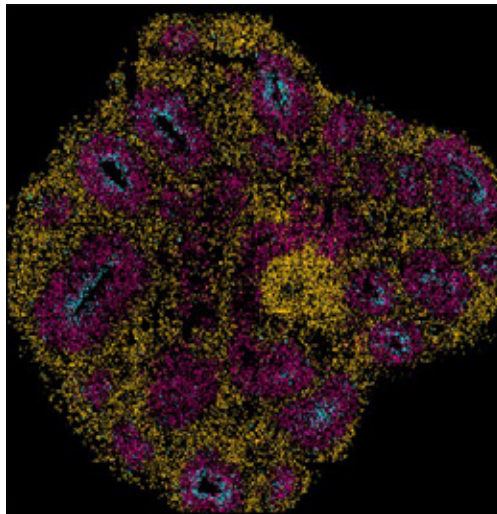
A*STAR and Pinduoduo, one of China's largest e-commerce platforms, teamed up to develop a cost-effective way of testing for contaminants in agricultural products. ✨ This collaboration

will leverage machine learning to develop a more accurate and cheaper testing method for pesticide residue. The end goal is to boost food safety, and increase consumer confidence.

RESEARCH COLLABORATIONS WITH INTERNATIONAL INDUSTRY PARTNERS


Uncovering a New Class of Spatial Molecular Biomarkers

Veranome Biosystems (VB) is the result of a multi-year research collaboration between A*STAR's Genome Institute of Singapore (GIS) and Applied Materials to develop and commercialise spatial RNA analysis solutions. VB leverages GIS' deep understanding of the genomics analysis workflow and biological applications, including single-cell sequencing and bioinformatics to uncover a new class of spatial molecular biomarkers that can improve the understanding of multiple diseases. In March 2021, VB unveiled the [world's first complete sample-to-insight high-plex spatial omics solution](#)  for single-cell level characterisation.



▲ RNA molecules in a brain organoid.


Diverse Drug Discovery Programs in Oncology

Cyclica entered into a [multi-year and multi-project collaboration with GIS](#)  to carry out research efforts spanning polypharmacology

profiling to novel compound design for diverse drug discovery programmes in oncology and related diseases.

Mitigating Antibiotic Resistance

Scientists from A*STAR collaborated with an international team of researchers from IBM Almaden Research Center in the United States, Sun Yat-sen University in China, and the Singapore-MIT Alliance for Research and Technology to [develop a novel polymer-antibiotic combination](#). 

The team discovered that the synergistic effects between the polymer and the antibiotic rifampicin blocked the activity of genes or proteins that cause drug resistance, while eliminating bacteria. The results of the study, titled [A Macromolecule Reversing Antibiotic Resistance Phenotype and Repurposing Drugs as Potent Antibiotics](#)  was published in *Advanced Science*.

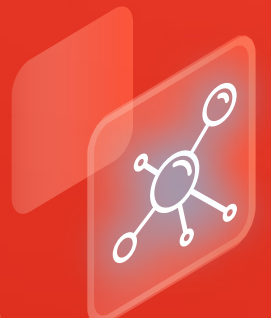


▲ Paving the way for new solutions to treat multidrug-resistant bacteria.



Addressing National Challenges with Multi-Disciplinary R&D Capabilities

Working together with the public sector and industry on solutions for sustainability, the built environment, and food security.



◀ To enhance Singapore's food security, A*STAR drives R&D and innovation in the areas of urban farming and agritech.

PUBLIC SECTOR CONTRIBUTIONS TO BETTER SERVE SINGAPORE

5G-enabled Technologies to Transform the Built Environment

A*STAR's Institute for Infocomm Research (I²R) and the Housing Development Board (HDB) have [inked two collaborations to transform the Built Environment sector](#) by developing [more productive ways to design, build, and maintain our city](#). Together, they will develop and adopt [5G-enabled robotic, drone and artificial intelligence technologies](#) that can help raise productivity and improve safety at construction sites. Both parties will also bring together the research community, agencies and industry partners to facilitate



▲ AI and machine learning technologies will be applied to video feeds to identify safety lapses in real time at construction sites.

partnerships in technology transfer and translate R&D outcomes into commercially-ready products.

Multi-purpose All-Terrain Autonomous Robot (M.A.T.A.R.)

Researchers from A*STAR's Institute for Infocomm Research (I²R) and HTX (Home Team Science and Technology Agency)

jointly developed M.A.T.A.R., an autonomous patrol bot that can complement police ground operations.



◀ (From left) Vanessa Choo, Engineer (Robotics, Automation and Unmanned Systems), HTX; Albertus Hendrawan Adiwahono, Senior Scientist, A*STAR's I²R; Ong Ka Hing, Deputy Director (Robotics, Automation and Unmanned Systems), HTX; Lee Guoming, Head (Robotics, Automation and Unmanned Systems), HTX.

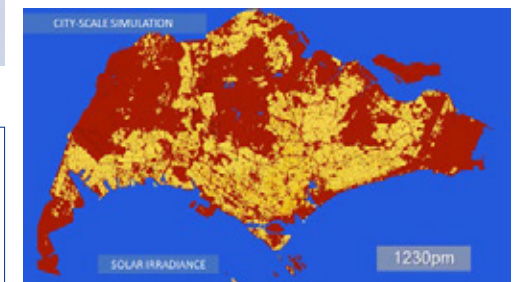
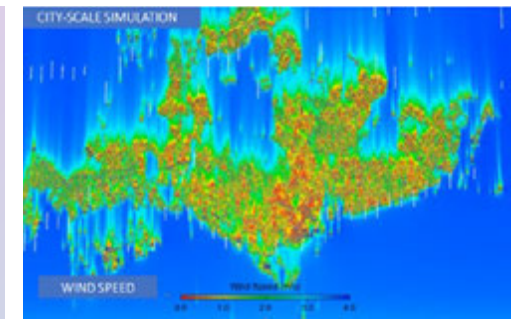
Visualising Environmental Factors to Optimise Urban Space Design

A team comprising of researchers from A*STAR's Institute of High Performance Computing (IHPC), I²R and engineers from HDB have developed a modelling tool that optimises the design of urban spaces for improved liveability. The Integrated

Environmental Modeller (IEM) is an advanced urban-planning tool that creates high-resolution 3D models of urban environments – to demonstrate how environmental factors such as solar irradiance, air temperature, wind and noise affect an urban setting.

IEM Highlights

- First-ever 3D wind-flow simulation that included all buildings in Singapore at a 10-metre resolution
- Garnered prestigious awards such as the President's Technology Award, the ASEAN Outstanding Engineering Achievement Award and the Minister for National Development's R&D Merit Award

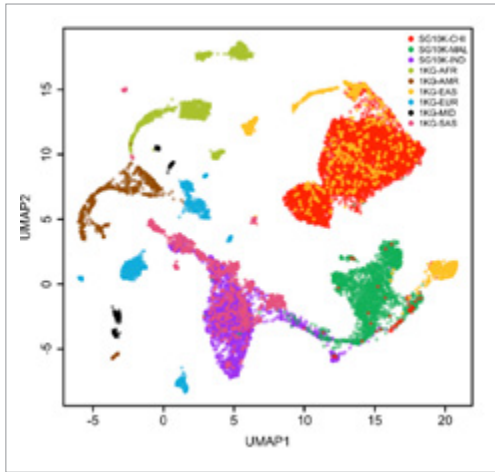


▲ Islandwide simulation – wind and solar irradiance

Tengah Town

IEM proved instrumental in the urban design plan for Tengah town, as it helped HDB's planners, architects and engineers analyse key wind channels and the solar heat gained by different urban features, such as concrete and vegetation. IEM helped the team to design open spaces as well as optimise the building layouts and orientation to promote natural ventilation within the town.

Medicine Tailored to Singapore's Population Diversity



▲ Two-dimensional projection of the Whole-Genome-Sequencing derived genetic relationship matrix capturing genetic variations across a compendium of ~10,000 NPM Phase1 Singaporean (SG10K) and ~3,000 International Genome Sample Resource (1KG) participating individuals.

Singapore's National Precision Medicine (NPM) programme was established in 2017 to enable a healthcare strategy that was tailored to Singapore's population diversity through precision medicine. By analysing data on a large scale, doctors could gain a more detailed understanding of each patient, to better predict and diagnose diseases. A*STAR contributes to the effort by providing a broad range of capabilities in data science and AI.

Phase 1 (2017–2021)

A*STAR's Genome Institute of Singapore (GIS) and partners from the local research and clinical communities created the world's largest genetic databank of Asian populations, represented by Chinese, Indian and Malays.

Phase 2 (2020–2024)

A*STAR's [Centre for Big data and Integrative Genomics \(c-BIG\)](#) is now supporting the [second phase of the NPM programme](#) together with Lee Kong Chian School of Medicine, National Healthcare Group, National University of Health System, National University of Singapore and SingHealth Duke-NUS Academic Medical Centre. Together, they will [complete genetic data of 100,000 healthy Singaporeans and up to 50,000 people with specific diseases.](#)

“The richness of the data provided by the database, combined with our knowledge of Asian genetics accumulated over the years, means that the clinical applications of genomics are vast.”

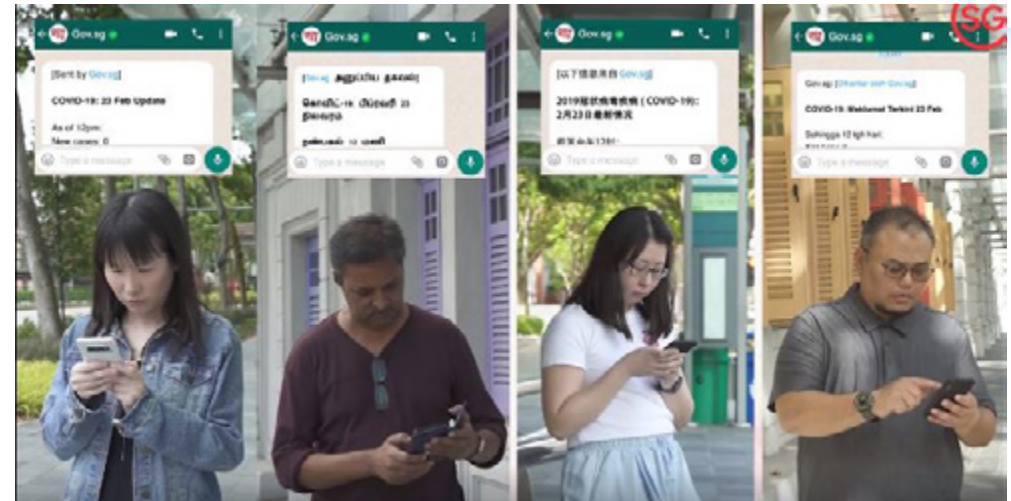
— Prof Patrick Tan

Executive Director of GIS, and Executive Director of PRECISE (Precision Health Research Singapore)

Using AI Translation Engine for Improved Public Communications

With the Ministry of Communications and Information, A*STAR researchers from I²R developed SG Translate, an AI translation engine deployed to assist public communication officers in their translation

of official materials. This technology is widely used by the government to improve work productivity and efficiency. It is also used in the COVID-19 updates on Gov.sg WhatsApp and Telegram to push out messages more quickly.



MANAGING SINGAPORE'S FOOD SUPPLY AND WASTE WITH INNOVATION

Sustainable Lighting Systems for High Productivity Farming

A*STAR's Agritech & Aquaculture Horizontal Technology Programme Office is supporting the nation to achieve its goal of producing 30 per cent of all nutritional needs locally by 2030. Through innovations such as [sustainable hybrid lighting systems that optimise the use of natural and artificial lighting](#)

[in vegetable farming](#), crop yields can be improved and energy consumption reduced. Other partners of this programme include A*STAR's Singapore Institute of Manufacturing Technology (SIMTech), National University of Singapore, Temasek Life Sciences Laboratory and Nanyang Technological University.



▲ Indoor farming has gained traction in highly urbanised countries such as Singapore. Crops can be grown in dense, vertically stacked layers.

Food Security through Sustainable Alternative Proteins



▲ President Halimah Yacob's visit to SIFBI.

Since 2018, A*STAR's Singapore Institute of Food and Biotechnology Innovation (SIFBI) has been involved in [helping Sophie's Bionutrients develop a new sustainable alternative protein out of microalgae](#). By leveraging SIFBI's

know-how in fermentation, flavour development, bioprocess engineering and design, Sophie's has managed to design a robust production process that can supply innovative plant-based food products for consumers' everyday diet.

Temasek in food tech innovation venture with A*Star

Temasek has signed an agreement with the Agency for Science, Technology and Research (A*Star) to establish the Food Tech Innovation Centre, a facility to accelerate the commercialisation of food technologies.

The state investor said the memorandum of understanding with A*Star is part of a renewed focus on increasing its investments in companies and start-ups at home and across Asia that use innovative technologies to produce food.

Source: *The Straits Times* © Singapore Press Holdings Limited. Permission required for reproduction.

Launchpad for Food Sustainability Start-ups

In November 2020, [SIFBI and Temasek signed a memorandum of understanding \(MoU\) to set up the Food Technology Innovation Centre \(FTIC\)](#). [Leveraging A*STAR's partnerships with multiple start-ups in the alternative food space, FTIC will aid in the novel food production processes and help alternative protein companies pilot manufacturing activities. This MoU positions Singapore as a launchpad for start-ups to test-bed and create innovative solutions that can tackle the region's evolving food and sustainability needs.](#)

Empowering Food Waste Management through On-site Audits

SIMTech and the Singapore Manufacturing Federation — Standards Development Organisation is helping to provide F&B companies with a [systematic way to audit food waste on their premises](#).

This initiative helps improve resource efficiencies and reduce carbon footprint by identifying food waste generation hotspots, the main causes, as well as suggests appropriate initiatives to reduce food waste. This methodology is based on the [Life Cycle Assessment \(LCA\) concept](#), which has been adopted



as the Singapore standard for food waste management in food manufacturing and retail establishments.



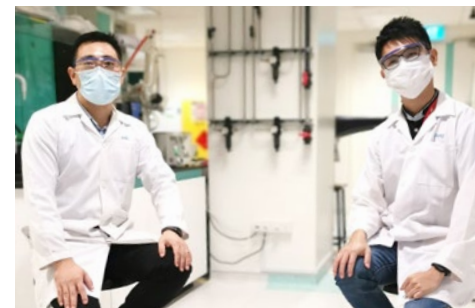
▲ Westcom fertiliser generated from food waste.

Waste Management Using a Patented Microbial Solution

Through a long-standing R&D process with A*STAR, local SME Westcom managed to develop a waste management system that turns food waste into fertiliser within 24 hours, without generating wastewater. Part of our developmental

assistance included helping Westcom set up its own in-house laboratory. Westcom's patented microbial solution has since successfully commercialised the technology in Singapore and internationally to the Taiwan and China markets.

Green, Strong and Robust Plastics



▲ Team lead Dr Li Zibiao (left) and senior specialist Jayven Yeo (right) from IMRE.

A*STAR's Institute of Materials Research and Engineering (IMRE) has [developed a material that could potentially be used to make biodegradable plastics](#). Made out of polylactic acid (PLA) material, it is malleable without having the drawbacks of conventional PLA materials such as brittleness. IMRE is now in talks with several fast-moving consumer goods companies to further develop the material for sustainable product packaging applications.



Nurturing Top Talent for the Singapore R&D Ecosystem

We are nurturing a pipeline of scientific talent for the local R&D ecosystem to maintain Singapore's position as one of the world's most innovative economies. This strategy builds a skilled talent pool adept at leveraging innovation to meet our nation's societal and economic needs.



◀ (From left) Dr Caroline Wee, Dr Sarah Luo and Dr Liang Kaicheng, recipients of the 2021 National Research Foundation Fellowship.

FUELLING INNOVATION IN LOCAL INDUSTRY

The Technology for Enterprise Capability Upgrading (T-Up) initiative seconds A*STAR Research Scientists & Engineers to local enterprises to upgrade their in-house R&D capabilities. Here are some exemplary A*STAR talent who have made impactful contributions to local enterprises.

T-Up Excellence Award Winners at SME Day 2020



▲ T-Up Excellence Award Winners with Dr Tan See Leng, Second Minister for Trade and Industry.



Dr Veeresh Juturu, research scientist at A*STAR's Institute of Chemical and Engineering Sciences (ICES), was seconded to local waste management firm Westcom Solutions to [help develop a unique microbial treatment](#), which would allow their food waste digester machines to convert large amounts of food waste into organic fertiliser. Dr Juturu played a key role in helping Westcom to set up its in-house R&D laboratory and production factory, and training its staff to manage the large-scale production of the proprietary microbe mixture.

The success of this T-Up project enabled Westcom to commercialise the new technology in Singapore, Taiwan and China markets, and position it for further growth into a large local enterprise.



Ms Chiu Ying Lay, senior research engineer at A*STAR's Institute for Infocomm (I²R), was seconded to Whizpace – an A*STAR spin-off that [taps on TV White Space \(TVWS\) to transmit data](#). During her attachment, Ms Chiu developed a network management system, which enabled the company to enhance and develop new WiFi products. She also supported Whizpace in the network planning and deployment of its products.

Whizpace Company Milestones

200%
compound annual growth rate
in sales from 2017 to 2019

Expanded customer base
from three countries to
17
in three years

7
patents to
its name

1st company to test TVWS with the
US Federal Communications
Commission

Raised \$1.2M for the expansion of its
Chinese subsidiary Whizpace
(Suzhou) Co. Ltd.



Senior scientist **Dr Manippady Krishna Kumar**, and research engineer **Mr Lance Tan** from A*STAR's Institute of Materials Research and Engineering (IMRE), helped homegrown company Champs Industrial to develop a disinfection water system using UV-C LED (a range of UV wavelength). UV-C LED is a safer alternative as compared to the widely used mercury-based ultraviolet (UV) light.

This project helped the homegrown manufacturer of electric water heaters increase its revenue.

T-Up Emerging Talent Award Winners at SME Day 2020



▲ T-Up Emerging Talent Award Winners with Second Minister for Trade and Industry, Dr Tan See Leng.



Dr Li Hongying, senior research scientist at A*STAR's Institute of High Performance Computing (IHPC), was seconded to ERS Industries to help develop an advanced computational fluid dynamics model for assessing the performance of the company's cool air management systems. This model helped the Singapore-based data centre solutions company accelerate its product design and development cycle by reducing prototyping and testing time.



Mr Tnay Guan Leong, senior research engineer at A*STAR's Singapore Institute of Manufacturing Technology (SIMTech), was attached to Fidel Engineering and Trading to help them with the development of a new machining technology, as well as staff training.

With Mr Tnay's help, Fidel managed to sharpen its competitive edge in the production of complex aerospace components by raising its manpower productivity. The company has also begun developing new products for the marine industry to capture new market opportunities.

NATIONAL AWARDS

2020 Public Sector Transformation Award: "Dare to Do"



▲ Dr Jaya Shankar and the I²R research team, recipients of the Public Sector Transformation Awards 2020.

The research team from I²R led by department head of intelligent transport systems **Dr Jaya Shankar** was recognised for developing the Cooperative and Unified Smart Traffic System, or CRUISE, in collaboration

with the Land Transport Authority. The team demonstrated the use of intelligent algorithms in the simulation of efficient road usage for diverse groups of road users.

The President's Science Award (PSA)



▲ Prof Liu receiving the PSA award from President Halimah Yacob, at the PSTA 2020 award ceremony.



Professor Liu Jianjun, deputy executive director of A*STAR's Genome Institute of Singapore (GIS), was awarded the [PSA for his outstanding contributions to genetic studies of Asian populations](#). His work has helped to advance biomedical research and precision medicine, as well as support clinical practice in preventing diseases and adverse drug responses.

Young Scientist Awards (YSA)



▲ Dr Chew (left) and Dr Tan (right) receiving the YSA award from Minister for Trade and Industry, Mr Chan Chun Sing, at the PSTA 2020 award ceremony.



Dr Chew Wei Leong, senior research scientist at GIS and an A*STAR scholar, has developed powerful CRISPR-Cas9 technology-based approaches for disease gene correction and gene expression control in the body. His [award-winning work opens up therapeutic avenues against multiple diseases](#), including severe inherited diseases, viral infections, blood disorders, eye diseases and cancers.

The work of Dr Chew and his team has also resulted in numerous patent applications and inventions in the fields of genome engineering and biotechnology. Some of these have been licensed to MNCs and form the technological foundations for new local start-ups.



Dr Tan Si Hui, formerly a director at A*STAR's Institute of Medical Biology (IMB) and now an associate director, biology at Cargene Therapeutics, was recognised [for her research on cancer and normal stem cells](#), in particular the identification of a novel marker that can be used to isolate human gastric stem cells. This discovery opens up new ways of studying gastric cancer stem cells and how they contribute to tumour growth. It could also potentially lead to novel therapeutic approaches that specifically target cancer stem cells.

Fellows of the Singapore National Academy of Science



Professor Barry Halliwell, chairman of A*STAR's Biomedical Research Council (BMRC) and **Professor Ng Huck Hui**, assistant chief executive of BMRC, have been elected fellows of the [Singapore National Academy of Science \(SNAS\)](#), which promotes the advancement of science and technology in Singapore. Together with other SNAS fellows, they play an important role in advising the government and other national organisations on various aspects of science including research, pedagogy, policy and public communications.

Singapore 100 Women in Tech (SG100WIT) 2020

The SG100WIT initiative celebrates women who have made significant contributions to tech in Singapore.



Dr Yang Yinping, senior scientist, principal investigator and group manager at IHPC, has a passion for developing intelligent technologies for high-value industry and societal applications. Among her achievements include teaching a computer to negotiate with a human, and understand sarcasm.

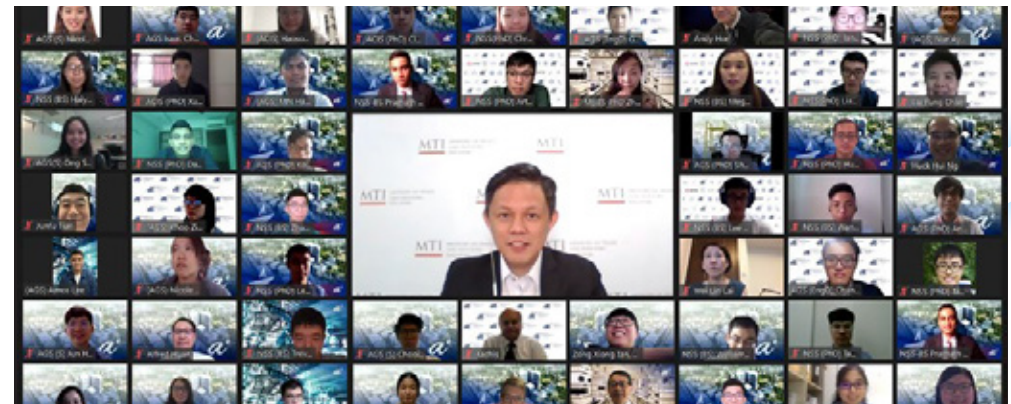


Internationally recognised in the field of engineering and technology, **Dr Savitha Ramasamy**, Scientist and Group Leader at I²R, has made impactful research in the fields of data mining, artificial neural network and artificial intelligence.

Institute of Physics Singapore Nanotechnology Physics Medal



Dr Teng Jinghua, principal scientist at A*STAR's IMRE, was recognised for his achievements in nanophotonics research, in particular his significant contributions to terahertz technologies, metamaterials and plasmonics.



▲ Minister for Trade and Industry, Mr Chan Chun Sing, A*STAR senior management and newly-minted scholars at the virtual SAC 2020 Award Ceremony.

A*STAR Scholarship Awards Ceremony 2020



The [A*STAR scholarship](#) was launched in July 2001 to develop local PhD talent in Singapore. The A*STAR Scholarship Awards Ceremony celebrates newly awarded scholars, and welcomes them into the A*STAR family. 66 scholarships were presented in 2020.

Minister for Trade and Industry, Mr Chan Chun Sing, was the Guest-of-Honour.

INTERNATIONAL AWARDS AND RECOGNITIONS

A*STAR Scientists on the Highly Cited Researchers 2020 List*

According to the Clarivate Analytics Web of Science Group, A*STAR's researchers are not just among the world's most influential in fields such as immunology, molecular biology and genetics, but are

also among the most prolific for cross-disciplinary work. They are a testament to A*STAR's multi-disciplinary approach, and strong collaborative research and innovation environment.

* Clarivate's Highly Cited Researchers 2020 list identifies influential researchers based on their publication of highly cited papers over the past decade. Their names are drawn from the top 1 per cent of publications in the Web of Science citation index.

1. **Dr Chen Jinmiao**
Principal Investigator, SlgN
2. **Dr Florent Ginhoux**
Senior Principal Investigator, SlgN
3. **Prof Loh Xian Jun**
Executive Director, IMRE
A*STAR Scholar
4. **Prof Michael Meaney**
Programme Director, SICS
5. **Dr Ng Lai Guan**
Principal Investigator, SlgN
6. **Prof Nick Barker**
Research Director, IMCB

7. **Dr Peter See**
Senior Research Fellow, IMCB
A*STAR Scholar
8. **Dr Seh Zhi Wei**
Senior Scientist, IMRE
A*STAR Scholar
9. **Dr Subhra K. Biswas**
Principal Investigator, SlgN
10. **Dr Zhang Lili**
Scientist, ICES
11. **Prof Zhang Yong-Wei**
Principal Scientist,
Deputy Executive Director
(Research), IHPC



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US National Academy of Engineering (NAE) Membership



A*STAR Senior Fellow and Head of NanoBio Lab (NBL), **Professor Jackie Ying** was elected as a [member to the US National Academy of Engineering \(NAE\) based on her research in Singapore.](#) Recognised for her contributions at the “interface of nanostructured materials, nanomedicine, and diagnostic devices to improve human health,” Prof Ying is one of only two new members who are based outside the US. She joins an exclusive group of just seven other NAE alumnus hailing from Singapore’s R&D ecosystem.

Visual Communications and Image Processing (VCIP) 2020 Grand Challenge

The Machine Intellection team consisting of researchers **Chen Zhenghua**, Scientist from I²R and **Yang Zaifeng**, Scientist, from IHPC; came in 2nd in the [Grand Challenge](#)

[on NIR Image Colorization,](#) IEEE International Conference on VCIP 2020. A total of 15 international teams participated in this challenge.

UG²+ Prize Challenge 2021

IHPC clinched first prize in the 4th UG²+ Prize Challenge 2021, under the sub-category “Track 2.1: Fully Supervised Action Recognition in the Dark”. Contesting against 35 international teams including Samsung AI, Tencent and DeepBlue Technology, the team demonstrated its ability to bridge the

gap between computational photography and visual recognition. Using a multi-model based zigzag learning method for action recognition, the team was able to train its system to recognise actions in dark environments, with a high accuracy rate.

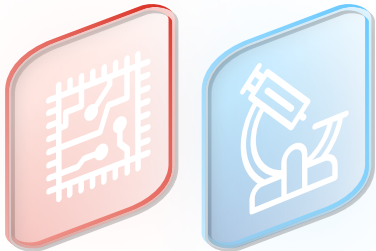


Team Members:

- 1. **Chen Zhenghua**
Scientist, I²R
- 2. **Jin Ruibing**
Scientist, I²R
- 3. **Yang Zaifeng**
Scientist, IHPC
- 4. **Hou Yubo**
Research Engineer, I²R
- 5. **Wu Keyu**
Scientist, I²R
- 6. **Wu Min**
Senior Scientist, I²R

SECURING SIGNIFICANT RESEARCH GRANTS (FY2020)

National Research Foundation (NRF) Fellowship Awardees



Three of A*STAR researchers were each awarded with a \$3 million fellowship grant from NRF, which provides early-career researchers with opportunities to carry out independent research in Singapore.

 [Full list of awardees over the years](#)

Awardee	Title	Research Topic
Dr Sarah Luo	Principal Investigator at IMCB	Metabolic circuits
Dr Caroline Wee	Research Fellow at IMCB	Gene-diet interactions affecting food choice
Dr Liang Kaicheng	Team Leader and Research Scientist at the A*STAR's Institute of Bioengineering and Nanotechnology (IBN)	Tissue pathology



▲ (From left) Dr Caroline Wee, Dr Sarah Luo and Dr Liang Kaicheng, recipients of the 2021 National Research Foundation Fellowship.

NRF Competitive Research Programme (CRP) Awardees


A team consisting of researchers **Prof Han Weiping**, lead principal investigator and deputy director from SBIC, A*STAR scholar; **Dr Tam Wai Leong**, group leader from GIS; and **Dr Philip Lee**, deputy director from SBIC; received funding from NRF's CRP for their research in "Integrating Magnetic Resonance Spectroscopy Imaging

Modalities with Metabolic Drug Therapy for Cancer Precision Medicine".

This programme funds use-inspired basic research projects and fosters multi-disciplinary teams to conduct cutting-edge research projects relevant to Singapore.

Open-Fund Individual Research Grant & Young Individual Research Grant Awardees in A*STAR

A total of 21 A*STAR researchers secured funds from the National Medical Research Council (NMRC) to nurture basic and translational clinical research that are relevant to human health, and treatment of diseases.

 [Full list of awardees](#)

Advanced Manufacturing and Engineering Young Individual Research Grants Awardees

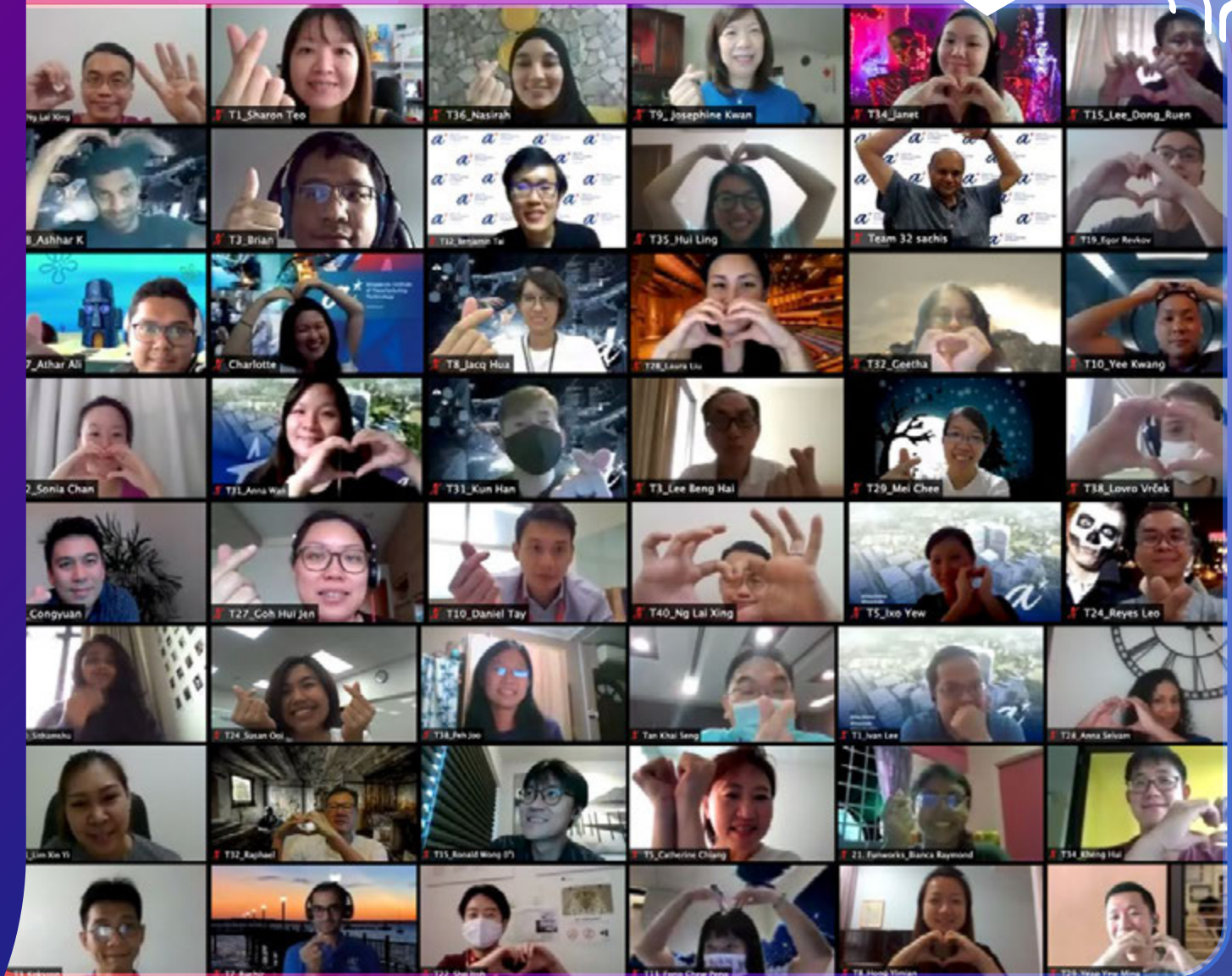
Administered by A*STAR, the grant funds early-career scientists focused on Advanced Manufacturing and Engineering. 16 A*STAR researchers were awarded after a rigorous selection process involving external

reviews by subject experts and globally leading scientists.

 [Full list of awardees](#)

HAPPY, HOMELY, HAPPENING A*STAR

A*STAR is committed to building a dynamic, progressive, family-friendly and inclusive workplace where our diverse workforce can thrive.



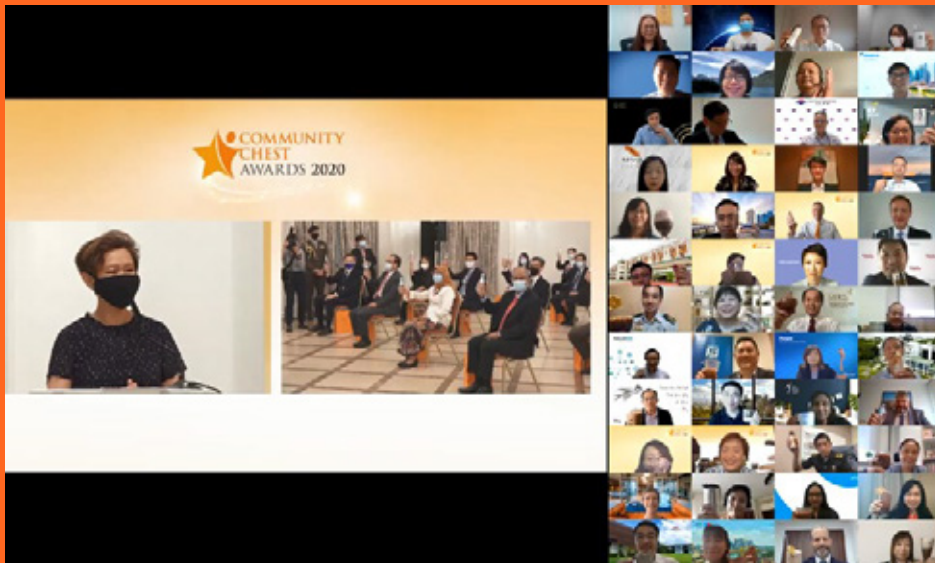
▲ A*STAR staff having fun at a virtual event organised by our Recreational Club.

BUILDING TIES IN THE COMMUNITY



Community Chest Awards 2020 – Bronze

We received Bronze in the Charity Awards category – presented to organisations and individuals who have made significant donations, amounting between S\$50,000 and S\$99,999.



▲ Community Chest Award 2020 virtual toast

Clean Up South West! Recycling Drive 2021

Our Corporate Social Responsibility (CSR) team partnered with the South West CDC to organise the Clean Up South West! programme and set-up booths at Fusionopolis and Biopolis to collect recyclables. Groceries purchased with the proceeds were then donated to vulnerable residents in the South West district.



▲ CSR recycling programme

A*STEP Challenge for Charity

Organised by A*STAR Rec Club and our CSR team, a total of S\$9,800 was raised and 16.5 million steps clocked over three weeks in October 2020.

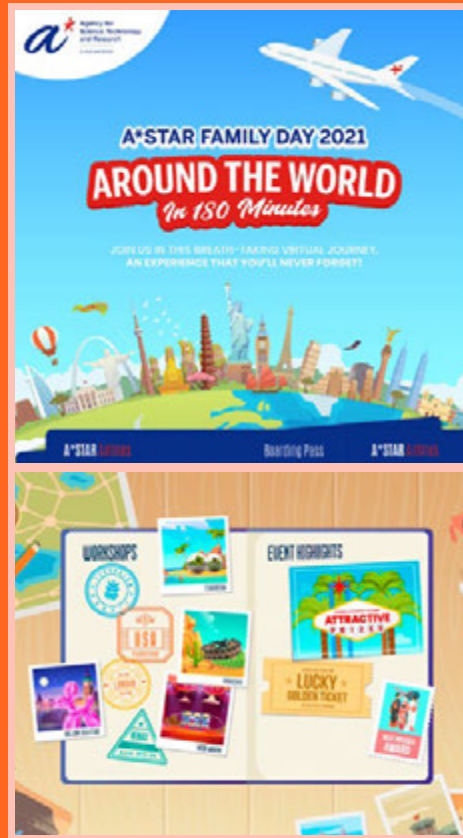


▲ A-STEP Challenge for Charity 2020

BUILDING BONDS IN THE A*STAR FAMILY

A*STAR Virtual Family Day 2021

To keep our spirits up, A*STAR organised a virtual Family Day. The event saw staff and their families taking part in hands-on online activities to make terrariums, DIY paracord bracelets and balloon sculptures.



Virtual National Day Observance Ceremony 2020

To celebrate National Day, A*STAR staff gathered virtually to celebrate Singapore's independence. The 2020 ceremony featured a performance of the national anthem by A*STAR senior management

and The Lab Rats — our very own band comprising scientists and researchers from across A*STAR. A video tribute to A*STAR's COVID-19 Heroes was also screened.



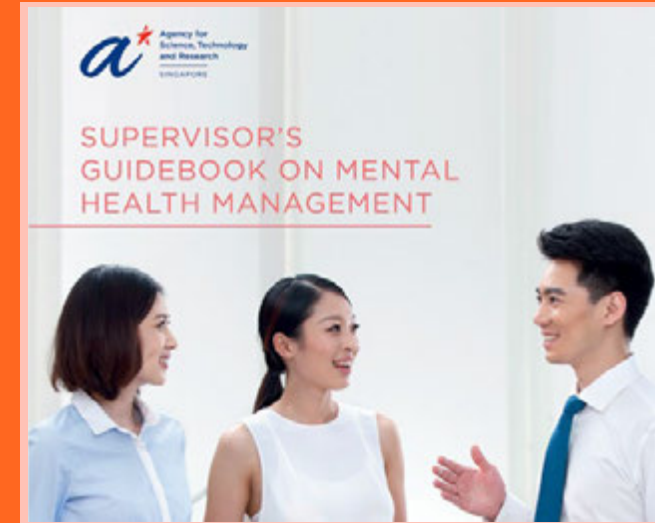
CHAMPIONING WELLNESS

A*STAR Infuse

The office champions employee wellbeing by developing Communities of Practice in parenting, mindfulness and networking. This is facilitated through corporate wellness programmes.

Infuse initiatives include:

- A*STAR Wellness Tool Kit, which consists of strategies, worksheets and tips to support the wellbeing of leaders and their teams
- Webinars based on themes such as Parenting in the New Normal, Work-life Harmony, Better Teamwork and Collaboration
- Supervisor's Guidebook on Mental Health Management covering topics such as Mental Health Issues in the Workplace, Supporting Staff in Distress, and Supportive Work Arrangements



KEY PERFORMANCE INDICATORS

RIE2020 KPIs		A*STAR Achievement (as at FY20 Q4)	RIE2020 Target
1	Industry R&D Projects*	7,492 (226%)	3,315
2	Industry R&D Spending (S\$ mil)	1,384 (115%)	1,200
3	Number of Licenses	1,133 (252%)	450
4	Number of Spin-offs	92 (177%)	52
5	Industry Cash Funding Received (S\$ mil) <i>[Tracking Indicator in RIE2020, subset of indicator no. 2]</i>	477 (148%)	322
6	Licensing Revenue (S\$ mil)	26.6 (177%)	15
7	Number of Research Scientists and Engineers from Research Institutes seconded to industry	324 (118%)	275
8	Number of PhD Postgraduates trained or being trained	607 (111%)	545

* Excludes Characterisation, Measurement and Technical Consultancy (C/M/TC) projects.

In addition to the indicators above, A*STAR's research was also published in 10,856 high-impact publications.

ORGANISATION DETAILS

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