Agency for Science, Technology and Research

SINGAPORE

CREATING GROWTH, ENHANCING LIVES

ANNUAL REPORT

April 2021 - March 2022

CONTENTS

Spot this icon for more content.

About A*STAR

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

A*STAR continued to contribute as a strategic innovation engine for Singapore in FY2021.

Long-term R&D investments have enabled A*STAR to play our part to address national needs and generate new opportunities for growth. Strong scientific fundamentals help to drive an innovation pipeline to enhance Singapore's economy, society, and future.

One key initiative in FY2021 was repositioning the Institute of Sustainability for Chemicals, Energy and Environment to support Singapore's sustainability goals, including the Singapore Green Plan and Zero Waste Masterplan.

To support Singapore's "30 by 30" food security goal of producing 30 per cent of Singapore's nutritional needs locally by 2030, A*STAR partnered Temasek Foundation to set up the Food Tech Innovation Centre as an ecosystem platform to help novel food start-ups accelerate their product and process development.

In the area of improving health outcomes, the Genome Institute of Singapore and the Bioinformatics Institute are contributing their genomics and bioinformatic capabilities to support Singapore's population cohort study, SG100K. This study will pave the way for faster diagnosis and targeted treatments through precision medicine.

Strong public-private partnerships continue to be key enablers in translating our science into impact. We contribute meaningfully to the innovation journeys of our industry partners, to assist them to go from technology to component to product. For instance, focused efforts were made in 2021 to stand up the A*STAR SIMTech Innovation Factory (SIF), in partnership with Enterprise Singapore, to support local companies in product innovation and development. In just over a year, SIF has helped a number of companies launch products into the market.

Together with our public sector colleagues, we continued to work on solutions to address national challenges.

Taking COVID-19 as an example, we partnered DSO National Laboratories to develop RESOLUTE, a direct PCR diagnostic kit for COVID-19. We were also part of a multi-agency team led by MOH to scale up national PCR testing capabilities. The Stronghold Diagnostics Lab, in partnership with NUHS and Temasek, worked tirelessly together with other public and private labs, to support the national testing effort. Working with the Health Sciences Authority (HSA), we also developed and implemented a COVID-19 vaccine lot release testing platform to ensure safe use of vaccines in Singapore.

The dedicated efforts of our researchers and scientists, together with our public sector colleagues, were recognised via several awards at the COVID Public Sector Transformation Awards Ceremony 2021, and the annual Firefly Awards.

Ultimately, people are at the heart of what we do at A*STAR. We are proud of what our staff have achieved and continue to be inspired by their passion to pursue impactful science that will create growth and enhance lives for Singaporeans. A*STAR continues to nurture top talent for the local R&D ecosystem through its scholarship programme, which has built a pipeline of over 1,700 R&D talents for Singapore since 2001.

As the lead public sector R&D agency in Singapore, we will continue to build deep capabilities to impact Singapore, Singaporeans, and Science.

Ms Chan Lai Fung
Chairman

Mr Frederick Chew
Chief Executive Officer

BOARD MEMBERS (AS OF 31 MARCH 2022)

CHAIRMAN

01 Ms Chan Lai Fung
Chairman, A*STAR

Permanent Secretary (National Research & Development), National Research Foundation

Permanent Secretary (Public Sector Science and Technology Policy and Plans Office), Prime Minister's Office

MEMBERS

02 Mr Frederick Chew
Chief Executive Officer, A*STAR

Chief (Public Sector Science & Technology Policy & Plans Office), Prime Minister's Office

03 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, National University of Singapore

04 Professor Sir John O'Reilly
Chairman, Science and Engineering Advisory Council, A*STAR

Chairman, NICC (Standards) Ltd

05 Professor Isaac Ben-Israel
Chairman, Israel Space Agency

06 Mr Ashok Belani
Executive Vice President, New Energy Schlumberger

07 Professor Stefan Catsicas
Managing Partner, Skyviews Life Science SA

08 Mr Chia Song Hwee
Deputy Chief Executive Officer, Temasek International Pte. Ltd.

09 Professor William Chin
Bertarelli Professor of Translational Medical Science and Medicine Emeritus, Harvard Medical School

Executive Vice President, Clinical and Translational Science, Frequency Therapeutics

10 Professor Jackie Hunter
Board Director, BenevolentAI Ltd

11 Dr Benjamin Koh Khay Wee
Deputy Secretary (Development), Ministry of Health

12 Professor Lily Kong
President, Singapore Management University

13 Dr Josephine Kwa
Director, Barghest Building Performance Pte Ltd

14 Mr Arunjai Mittal
Chairman, Advanced Micro Foundry Pte Ltd

15 Ms Jacqueline Poh
Managing Director, Economic Development Board

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 Pte Ltd

18 Mr Soh Gim Teik
Partner, Finix Corporate Advisory LLP

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 EXECUTIVE MANAGEMENT (AS OF 31 MARCH 2022)

SENIOR MANAGEMENT

01 Mr Frederick Chew
Chief Executive Officer, A*STAR

02 Mr Suresh Sachi
Deputy Chief Executive (Corporate)

General Counsel, A*STAR

03 Professor Andy Hor
Deputy Chief Executive (Research), A*STAR

04 Professor Ng Huck Hui
Assistant Chief Executive, Biomedical Research Council

05 Professor Alfred Huan
Assistant Chief Executive, Science & Engineering Research Council

06 Professor Tan Sze Wee
Assistant Chief Executive, Enterprise

SENIOR SCIENTIFIC ADVISORS

07 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, National University of Singapore

08 Professor Sir John O'Reilly
Chairman, Science and Engineering Advisory Council, A*STAR

Chairman, NICC (Standards) Ltd

09 Professor Ong Yew Soon
Chief Artificial Intelligence Scientist, A*STAR

President's Chair Professor of Computer Science, Nanyang Technological University

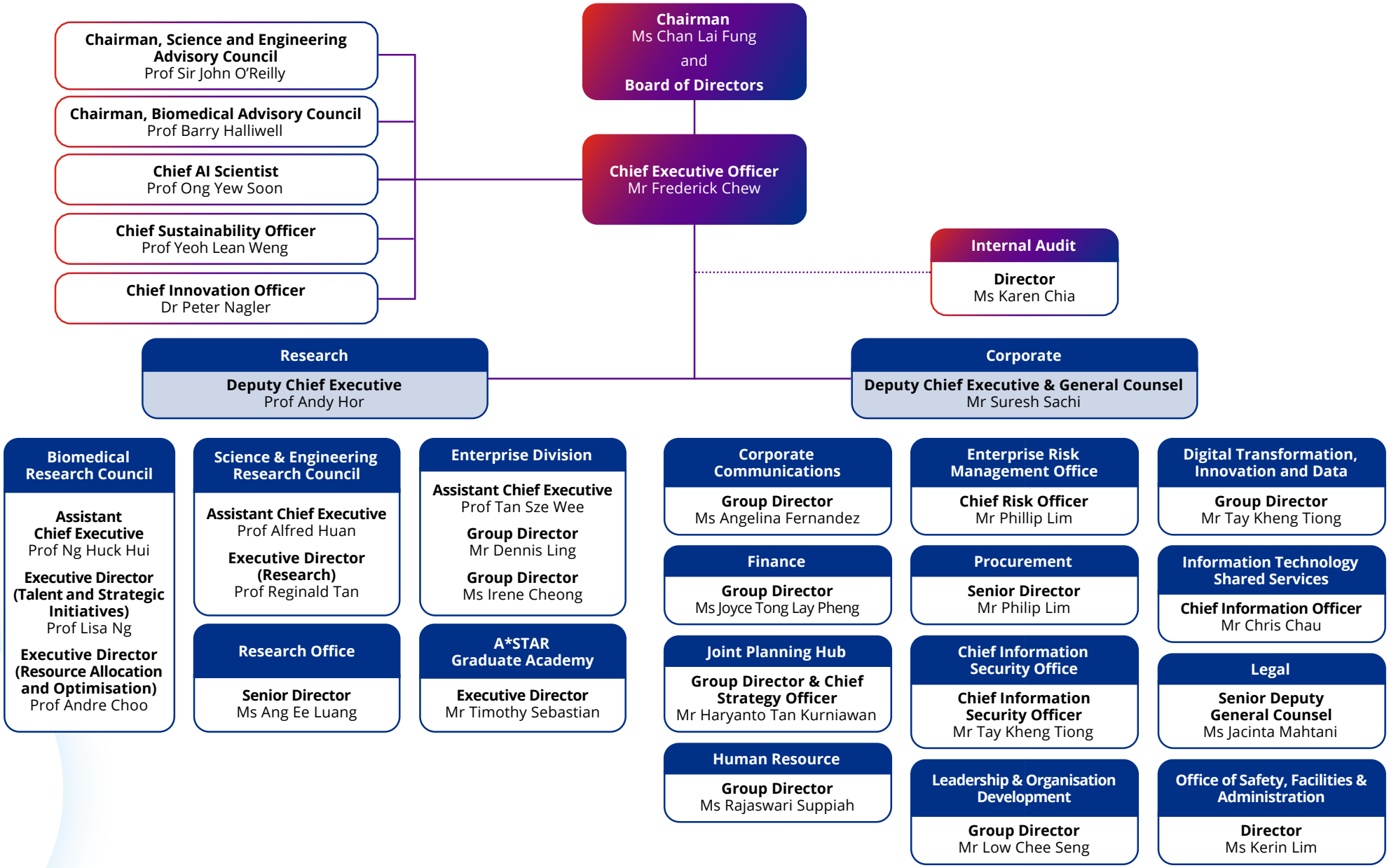
10 Professor Yeoh Lean Weng
Chief Sustainability Officer, A*STAR

Executive Committee Member, Institute of Sustainability for Chemicals, Energy and Environment

11 Dr Peter Nagler
Chief Innovation Officer, A*STAR

Advisor, Institute of Sustainability for Chemicals, Energy and Environment

ORGANISATION CHART (AS OF 31 MARCH 2022)



SUBSIDIARY COMPANY

Name of subsidiary company

Accelerate Technologies Pte Ltd (A*ccelerate)

% of shareholdings A*STAR has 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 group. 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 more than 5,800 strong as of 31 March 2022.

Biomedical Research Entities

- A*STAR Infectious Diseases Labs (ID Labs)
- A*STAR Skin Research Labs (A*SRL)
- Bioinformatics Institute (BII)
- Bioprocessing Technology Institute (BTI)
- Genome Institute of Singapore (GIS)
- Institute of Bioengineering and Bioimaging (IBB)
- Institute of Molecular and Cell Biology (IMCB)
- Singapore Immunology Network (SIgN)
- Singapore Institute for Clinical Sciences (SICS)
- Singapore Institute of Food and Biotechnology Innovation (SIFBI)

Science and Engineering Research Entities

- Advanced Remanufacturing and Technology Centre (ARTC)
- Institute of Chemical and Engineering Sciences (ICES)
- Institute of High Performance Computing (IHPC)
- Institute for Infocomm Research (I^2R)
- Institute of Materials Research and Engineering (IMRE)
- Institute of Microelectronics (IME)
- National Metrology Centre (NMC)
- Singapore Institute of Manufacturing Technology (SIMTech)

National Platforms

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

- Biomedical Sciences Industry Partnership Office (BMS IPO)
- Consortium Management Office (CMO)
- Diagnostics Development (DxD) Hub
- Experimental Drug Development Centre (EDDC)
- Low Carbon Energy Research Coordinating Office (LCER CO)
- National Robotics R&D Coordination Office (NRPCO)
- National Supercomputing Centre (NSCC)
- Singapore Biodesign (SB)
- Technology Centre for Offshore and Marine, Singapore Ltd (TCOMs)
- Urban Solutions & Sustainability Innovation & Enterprise (USS I&E)

Horizontal Technology Programme Offices

- Agritech & Aquaculture
- Artificial Intelligence, Analytics and Informatics
- Health and Medical Technologies
- Infectious Diseases
- Robotics
- Social Sciences and Technology
- Urban and Green Technology

Joint Institutions

- Skin Research Institute of Singapore (SRIS)

FY2021 AT A GLANCE

>1,800 projects
Undertaken with Companies (Industry Projects)

>$480M
Industry R&D Spending

Supporting Local Enterprises' Productivity and Growth

>80% projects with SMEs and Start-ups

>15% projects with LLEs

>60 Research Scientists and Engineers seconded to industry

Advancing Quality Science

1.5 **A*STAR publications' average Field-Weighted Citation Impact** in RIE 2025*

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

17.2%
of our publications were amongst the top 10% of the world's most highly cited

Strengthening Innovation and Enterprise

PRODUCTISATION & SPIN-OFFS

12 **successful A*STAR Spin-offs**

Attracted
>$290M
of follow-on **funding**

LICENSING

88
licenses taken up by 79 companies

>65%
to **SMEs** and **spin-offs**

Contributing to Public Sector Transformation

266 **projects** undertaken with public sector agencies

Attracting and Building Pipeline of STEM Talent

As at end FY2021, A*STAR has built a pipeline of

1,731
R&D talent through a suite of scholarships since 2001

60
A*STAR scholarships awarded in FY21

Key Achievements

KEY ACHIEVEMENTS

HELPING TO TRANSFORM SINGAPORE'S ECONOMY ▸▸

A*STAR is supporting and advancing the digitalisation and innovation journey of our local enterprises. Using our applied and translational research expertise, we strive to help Singapore-based companies build deep capabilities, and enable them to deliver market-leading products and services in the industries of tomorrow.

▸ *A*STAR's Supply Chain Control Tower*

ENABLING LOCAL COMPANIES TO BECOME GLOBALLY COMPETITIVE

Expansion of Talent Secondment Scheme to Support Singapore Firms Overseas, and Provide Additional Support

Through the Technology for Enterprise Capability Upgrading (T-Up) programme, A*STAR's research and engineering talent can now be seconded abroad to assist local enterprises in developing innovative products and achieve their business outcomes.

A*STAR has also partnered the Singapore Institute of Technology (SIT) to provide SIT students opportunities to work with seconded A*STAR scientists under T-Up. This will develop a pipeline of Innovation & Enterprise talent for the industry, while accelerating transfer of technological know-how within the ecosystem.

Trade and Industry Minister Gan Kim Yong (fifth from left) with this year's recipients of the T-Up Awards at the Agency for Science, Technology and Research's SME Day, which was held yesterday as part of the Singapore Week of Innovation and Technology at JW Marriott Hotel Singapore South Beach. ST PHOTO: KUA CHEE SIONG

A*Star's talent secondment scheme expanded for R&D projects abroad

Choo Yun Ting

to work with over local 850 firms since the programme was introduced in 2003.

market-viable products," he said. Three A*Star research scientists and engineers were given

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction.

Launch of Technology and Innovation Partnership Programme in Suzhou Industrial Park

A*STAR Partners' Centre (A*PC) launched the A*STAR-Suzhou Industrial Park Technology and Innovation Partnership Programme to give Singapore companies a better understanding of business development and access to opportunities in China. This is achieved through facilitating interactions with outstanding entrepreneurs, scientists, academics and investors.

▲ *The first 10 mentors officially appointed at the launch event on 14 January*

*A*STAR spinoff, Lucence, which specialises in early cancer detection was one such company that was able to establish a presence in Suzhou Industrial Park through A*PC. In 2021, Lucence begun providing the LiquidHALLMARK® test-based research service for early cancer screening in China, as well as commenced National Medical Productions Administration registration for their products.*

Growing the Electric Vehicle (EV) Market

A*STAR's Institute of Microelectronics (IME) and global semiconductor leader STMicroelectronics are collaborating in silicon carbide (SiC) R&D for power-electronics applications in the automotive and industrial markets. This partnership will provide added opportunities to engage with companies on SiC research projects, and promote Singapore as an ideal location for high-value R&D activities.

Using Artificial Intelligence (AI) to Automate Orthodontic Design and Surgical Planning

Singapore Dental Star R&D Investment Company engaged A*STAR's Singapore Institute of Manufacturing Technology (SIMTech) to develop an AI-powered software to streamline orthodontic design and surgical planning, and reduce the workload of dentists and orthodontists.

Joint Lab to Develop 3D Plus Vision Technologies

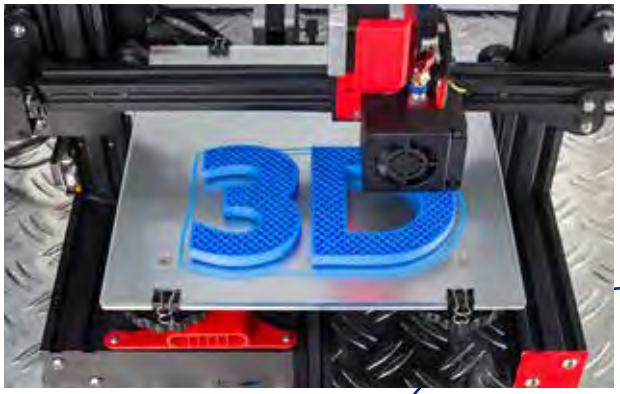
The Intelligent Vision Joint Lab is a R&D collaboration between JM VisTec System (JM VisTec) and A*STAR's Advanced Remanufacturing and Technology Centre (ARTC), SIMTech and Institute for Infocomm Research (I^2R). The lab will develop new products for security, surveillance and autonomous vehicles, as well as next-generation intelligent vision systems.

Gene Therapy Technology Licensed by Biotech Company

Singaporean preclinical-stage biotech company, Nuevocor, has licensed Skin Research Institute of Singapore's (SRIS) gene therapy technologies to address diseases that weaken the heart's ability to pump blood.

Development of 3D-printed Scaffold for Oral and Facial Bone Regeneration

Homegrown SME Osteopore International signed a collaborative agreement with A*STAR's SIMTech, Institute of Molecular and Cell Biology (IMCB) and the National Dental Centre of Singapore to develop bioactive and bioresorbable 3D-printed scaffold for oral-maxillofacial bone regeneration. This partnership will support commercialisation of Osteopore's bone regenerating implants as well as scale up their Good Manufacturing Practice facility and 3D printing capacity.



IMPROVING PRODUCTIVITY IN LOCAL COMPANIES

▲ *A*STAR's Supply Chain Control Tower*

Supply Chain 4.0 Initiative to Keep Supply Chains Agile and Secure

A*STAR, together with the National University of Singapore (NUS) and Singapore University of Technology and Design, kicked off a Supply Chain 4.0 initiative to develop digital and automation solutions that can give local businesses better visibility of their supply chains. These solutions will be tested at the new Supply Chain Control Tower at A*STAR's ARTC.

Joint Lab to Develop Artificial Intelligence (AI) Solutions for Improving Airline Operations

Singapore Airlines Limited (SIA) and SIA Engineering Company collaborated with A*STAR to develop advanced AI solutions for improving engineering productivity, customer experience and cost-effectiveness of airline operations.

Enhancing Digital Transformation with Local Manufacturing Firms

A*STAR's SIMTech has teamed up with 10 manufacturing firms to incorporate digital innovations into their business solutions. The partnership covers masterclasses and training, as well as research collaborations to strengthen their economic resilience and supply chain.

SIMTech teams up with 10 firms to enhance digital transformation

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction.

Partnership with PSA to Manage Large-scale Automated Guided Vehicle (AGV) Fleets

A*STAR's Institute of High Performance Computing (IHPC) and PSA Singapore signed a research collaboration agreement to develop a large-scale fleet management solution to move containers efficiently and securely at Tuas port. This collaboration is expected to reduce infrastructure and operational costs, and bring Singapore closer to its vision of developing an intelligent, resilient and sustainable port of the future.

Photo credit: PSA Singapore

ANCHORING INTERNATIONAL R&D INVESTMENTS IN SINGAPORE

Applied Materials and A*STAR Extend R&D Collaboration with New $286m Investment

A*STAR's Institute of Microelectronics (IME) and American chip-equipment maker, Applied Materials, have extended their research collaboration to 2026. The new investment will go towards upgrading the joint lab that was set up in 2011, to help accelerate materials, equipment and process technology solutions for hybrid bonding, as well as other emerging 3D chip integration technologies.

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

▲ *Mr Gan Kim Yong, Minister for Trade and Industry (third from left) presided at the ceremony to kick off the third phase of the R&D collaboration between A*STAR and Applied Materials.*

Staff at the Centre of Excellence in Advanced Packaging, which was jointly set up by US-headquartered Applied Materials and A*Star's Institute of Microelectronics in 2011. PHOTO: APPLIED MATERIALS

US chip equipment maker and A*Star extend collaboration

$286m investment in third phase of R&D efforts to drive semiconductor innovation

Choo Yun Ting

Singapore is gearing up to meet the Materials unveiled yesterday.

The US-headquartered manufacturer and the Institute of Microelectronics (IME) under Singapore's Agency for Science, Technology tre of Excellence in Advanced Packaging in Singapore, was set up in 2011 to develop advanced 3D chip packaging capabilities.

The latest investment will go towards upgrading and expanding the centre to accelerate materials, equipment and process technology solutions for hybrid bonding and other emerging 3D chip integration and prototyping hybrid bonding package designs.

Hybrid bonding technology is Applied Materials and IME have now invested US$450 million in total in the three phases of collabo-

Trade and Industry Minister Gan Kim Yong (left) visiting the centre yesterday during the launch of the extended research collaboration between Applied Materials and A*Star's Institute of Microelectronics. ST PHOTO: MARK CHEONG

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction.

> *The technologies that we are enabling from Singapore are basically for all our global customers in the entire global semiconductor system, so that connection and that exposure for the talents working in the Centre of Excellence are very, very exciting.*
>
> **Mr Brian Tan**
> Regional president for Applied Materials South-east Asia

Extension of 3D-printing Partnership with Hitachi Metals

A*STAR's SIMTech and Hitachi Metals Singapore have extended the joint lab collaboration for another three years, to help manufacturers achieve better quality printed parts.

A*Star, Hitachi Metals extend 3D-printing tie-up to support manufacturers

Wallace Woon

Manufacturers in Singapore which use metal powders for 3D printing can receive further support after a three-year extension was inked last Friday between the Agency for Science, Technology and Research's (A*Star) Singapore Institute of Manufacturing Technology (SIMTech) and Hitachi Metals Singapore for their joint laboratory collaboration.

The SIMTech-Hitachi Metals joint lab will also get an additional $8.5 million from the two partners, bringing the total amount invested to $14 million since the tie-up started in 2018.

According to Dr Yusaku Maruno, head of Hitachi's Materials Solution Centre in Singapore, 3D printing has wide applications, including in the aerospace and automotive industries, oil and gas sector, as well as semiconductor manufacturing.

SIMTech acting research division director Sharon Nai said that, over the past three years, the lab has established methods to optimise metal powders for 3D printing and developed end-to-end 3D printing solutions.

Dr Nai added: "We (the joint lab) have looked at developing end-to-end 3D printing solutions for Hitachi Metals' components to meet their industrial application needs."

Second Minister for Trade and Industry Tan See Leng was at Hitachi Metals' plant in Pioneer to witness there are limitations."

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction.

*Dr Tan See Leng, Second Minister for Trade and Industry, touring the Hitachi Metals Singapore and A*STAR additive manufacturing joint lab.*

Deepening Research Collaboration Glaxo Wellcome Manufacturing

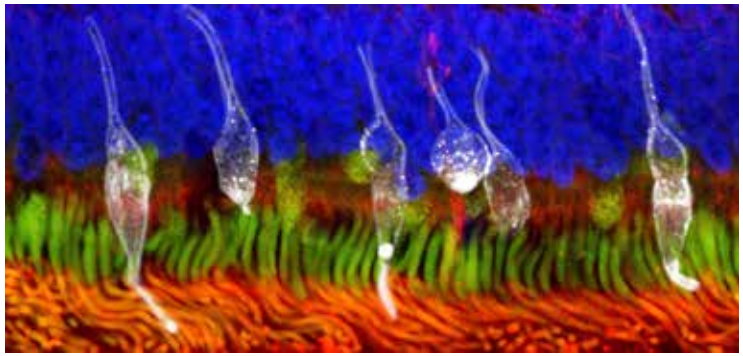
At the end of Phase 1 of the Glaxo Wellcome Manufacturing-Bioprocessing Technology Institute (GSK-BTI) Research Collaboration Agreement signed in 2020, A*STAR successfully demonstrated BTI's membrane-free cell retention device – uVisFlo, which led to the continuation of the next phase of collaboration to further develop the commercial readiness of uVisFlo.

Partnership with Johnson & Johnson (J&J) to Treat Eczema

A*STAR's SRIS inked a collaboration agreement with American Pharmaceutical company J&J World Without Disease Accelerator Team's Healthy Baby Initiative. The collaboration will involve screening natural compound libraries to identify a suitable compound to treat atopic dermatitis, and preclinical studies thereafter.

Developing Stem Cell Therapeutics for Age-related Diseases

A*STAR's IMCB has signed a deal with United States-based biotech company RxCell Inc, Singapore Eye Research institute (SERI) and NUS to develop cellular therapy solutions for age-related retinal and musculoskeletal degeneration, which will provide new ways of treatment.



Retinal progenitor cells derived from RxCell induced pluripotent stem cells can mature into retina photoreceptors after transplantation into the preclinical models, enabling restored vision.

STRENGTHENING SINGAPORE'S LEADING GLOBAL POSITION AS AIR AND SEA TRANSPORT HUBS

Boosting Air Traffic Operation and Management

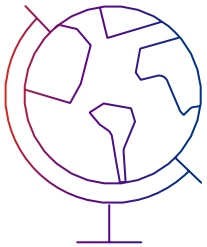
A*STAR's Institute for Infocomm Research (I^2R) collaborated with the Civil Aviation Authority of Singapore (CAAS) and industry partners to study how Artificial Intelligence (AI) can help advance Singapore's air traffic management capabilities in demand prediction and trajectory optimisation, understand the impact of convective weather on flight routes, transcribe air-ground voice communications automatically and perform intelligent scheduling and allocation of air tugs.

Improving Vessel Navigation in Singapore Port Waters

A*STAR's IHPC and industry partners conducted research on digital intelligence solutions to optimise operations of port and shipping lines. Leveraging maritime big data, the objective is to improve direct berthing of vessels at the port and reduce dwell time at the anchorages. This project is funded by the Maritime Transformation Programme administered by Singapore Maritime Institute, and the National Research Foundation.

Enhancing Maritime Communications

A*STAR's I^2R and ST Engineering completed the development of the Shipborne VHF Data Exchange System (VDES) communication terminal, to support the testing of new operating concepts and applications to raise VDES standards and eventually replace the existing automatic identification system. VDES enables global seamless maritime data communication connectivity via terrestrial and satellite links to improve shipping and port efficiency. This project is funded by the Maritime Innovation and Technology fund from the Maritime & Port Authority of Singapore.



KEY ACHIEVEMENTS

ADDRESSING NATIONAL CHALLENGES WITH MULTI-DISCIPLINARY R&D CAPABILITIES ▸▸

*(From left) Prof Lisa Ng, Executive Director and Wendy Chen, Research Officer at A*STAR's ID Labs observing cloned colonies of E. coli on agar plates.*

CONTRIBUTING TO BETTER SOCIETAL OUTCOMES

Launch of SMU-A*STAR Joint Lab in Social and Human-Centred Computing

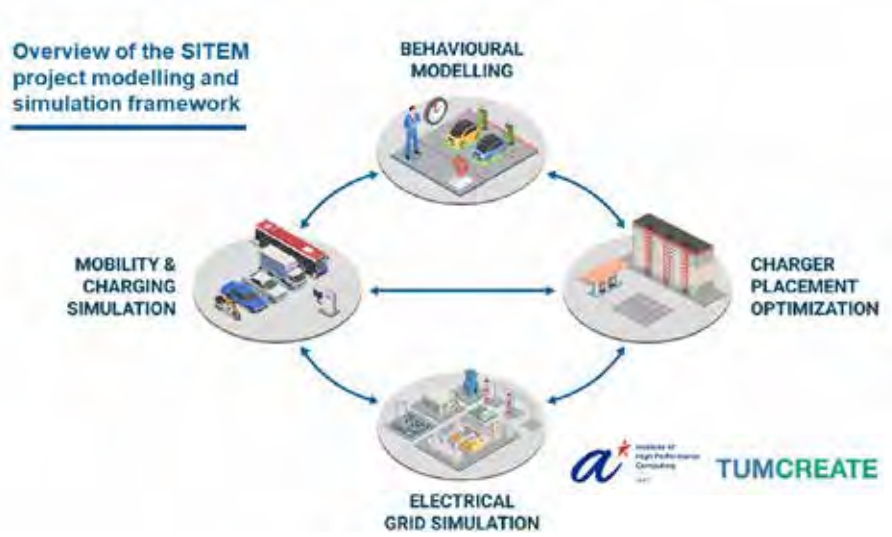
A*STAR and Singapore Management University (SMU) established a Joint Lab in Social and Human-Centred Computing, which will tap on computational methods and AI to understand and anticipate human behaviour, to help develop better technological solutions that can address national priorities.

▲ *Front row (L to R): Prof Timothy Clark, SMU; Mr Peter Ho, Social Science Research Council; A*STAR Chairman Ms Chan Lai Fung; A*STAR CEO Mr Frederick Chew*

*Back row (L to R): A*STAR DCE (Research) Prof Andy Hor, Prof Archan Misra, SMU; A*STAR ACE (SERC) Dr Lim Keng Hui*

Supporting Decarbonisation Efforts through Advanced Systems Modelling and Simulation

A*STAR's IHPC and the Technical University of Munich at the Singapore Campus for Research Excellence and Technological Enterprise (TUMCREATE) collaborated on the Singapore Integrated Transport Energy Model (SITEM) to analyse projected EV charging patterns and energy demand. These findings will help to shape policies relating to Singapore's transition to EVs nationwide.



▲ *Overview of SITEM project modelling and simulation framework*

Public Transport Sentiment Analysis Tool

To support public transport policymaking, A*STAR's IHPC developed a digital tool to observe commuter sentiments. The tool is able to analyse unstructured social media content, as well as process colloquial language and sarcasm.

▲ *Reasonance Social dashboard*

Working with Local Start-up to Develop Wireless Asset Tracking Systems in Hospitals

A*STAR and I.O.T. Workz jointly developed a system to automatically track the physical location of wheelchairs at Khoo Teck Puat Hospital. This system has improved productivity at the hospital by ensuring availability of wheelchairs, and has potential to be further used in industrial IoT, smart buildings and environmental monitoring applications.

> *Our collaboration with A*STAR has enhanced our service offerings, allowing us to target new market segments. We look forward to developing our long-term working relationship with A*STAR to further add value to the technology and manufacturing ecosystem in Singapore.*
>
> **Mr Shawn Koh**
> Founder of I.O.T Workz

Photo credit: Khoo Teck Puat Hospital

CONTRIBUTING TO BETTER HEALTH OUTCOMES

HEALTH AND HUMAN POTENTIAL / GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES (GUSTO) FINDINGS

Mental Health of Mothers Can Affect Changes in Babies' Brains

Nearly 40 per cent of mothers had high levels of depressive symptoms, which were associated with changes in their babies' brains. These findings form the basis for future plans to help women stay in good physical and mental health for motherhood, support the development of a healthier next generation, and reduce the prevalence of childhood obesity through sustained lifestyle changes.

Funding to Study Early Childhood Brain Development

An international consortium led by Professor Sir Peter Gluckman, Chief Scientific Officer at A*STAR's SICS, has been awarded a multi-million-dollar contract by Wellcome Leap. This programme comes under Wellcome's "The First 1,000 Days" programme which examines the factors that influence human brain development in early life.

Weight Gain Due to Lack of Outdoor Play During Circuit Breaker

In a collaborative study with KK Women's and Children's Hospital, National University Hospital (NUH) and NUS's Yong Loo Lin School of Medicine, A*STAR's SICS discovered that the median body mass index of 9 to 11-year-old boys in Singapore had increased from 16.3 to 19.1 during the circuit breaker from March to May 2020. This result was attributed to the cessation of outdoor play during this period.

Kids gain weight after circuit breaker from no outdoor play

Study of 585 kids finds that for one group, for example, median BMI rose from 16.3 to 19.1

Cheryl Tan

Children in Singapore put on weight after the two-month circuit breaker, which saw residents adhering to a strict stay-at-home or- ties resumed soon after, yet a substantial number of children had reported elimination of all outdoor activities, which could have led to an increase in body mass among this group."

Previous studies have established strong links between obesity in children and adults.

For example, a Health Promotion Board study in 2017 showed that 70 per cent of overweight children later became obese adults.

Obesity has a correlation with chronic diseases such as diabetes, high blood pressure and heart disease later in life if left unattended.

Ms Sum Ka Kei, an epidemiologist at SICS and first author of the study, said active play indoors may not be sufficient to replace outdoor activity, particularly for children who are older.

"It is important to understand how to address this effectively, as outdoor time is associated with numerous other benefits to children, including better sleep, learning and socio-emotional development."

tansuwen@sph.com.sg

Over a third of schoolgoers and a quarter of pre-school children did not have any outdoor play two months after the circuit breaker. PHOTO: LIANHE ZAOBAO

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction.

PRECISION MEDICINE / CAPABILITIES IN GENOME SEQUENCING

Mapping Our Genes: SG100K Population Study

Singapore has embarked on a three-year-long population study (SG100K) to map the complete set of genes of 100,000 Singaporeans to improve health outcomes and prevent diseases. A*STAR's Genome Institute of Singapore (GIS) is one of the core institutions involved in the study, and will conduct DNA extraction and validation work on blood samples taken from research subjects.

Genomic Analysis of Peranakan Chinese Reveals Insight into Ancestry

A team from A*STAR's GIS embarked on a project to analyse the genomes of 177 Singapore Peranakans to advance their understanding of Chinese interaction patterns with the indigenous populations of Southeast Asia. Genetic data generated by this project may subsequently be used to improve human health outcomes.

Joint Service Lab with Avatamed to Offer Precision Oncology Services

Avatamed teamed up with A*STAR's IMCB to set up a joint service lab, which will offer its proprietary drug screening technology (AVATASCAN) to oncologists and pharmaceutical companies. The initiative aims to improve treatment outcome for cancer patients.

DIGITALISATION OF HEALTHCARE

Partnership with the National Cancer Centre of Singapore (NCCS) to Develop Digital Medicine

A*STAR's Bioinformatics Institute (BII) and IMCB partnered with NCCS to develop cloud-based data analytics software tools that can aid clinicians in diagnosing drug sensitivity in lung cancer patients.

Driving Healthcare Transformation with Data

▲ *The Respiree system*

Changi General Hospital (CGH) and A*STAR spin-off Respiree signed a research agreement with A*STAR's Institute of Bioengineering and Bioimaging and I²R to develop, validate, and integrate predictive analytics into general care and home-care monitoring systems. The envisioned end-product is an all-integrated interface that tracks the patient's journey from hospital registration to rehabilitation at home.

Collaboration with Tessa Therapeutics to Form Cell Therapy Laboratory

A*STAR's IMCB and Tessa Therapeutics jointly came up with a new facility to harness preclinical technologies and accelerate the clinical development of new therapeutic targets against cancer.

MicroRNA Blood Test for Detection of Early-stage Gastric Cancer

GASTROClear was launched as a result of the collaboration from NUHS, NUS, NUH, A*STAR's BTI, DxD Hub as well as MiRXES, a local biotech company. It is a microRNA-based blood test that can accurately detect gastric cancer in its early stages, and has been rolled out in public hospitals such as Tan Tock Seng Hospital, NUH, private general practitioner clinics and specialist's clinics for pre-screening of gastric cancer.

Developing New Therapy for Chronic Wounds

Scientists from SRIS, Nanyang Technological University (NTU) and A*STAR spin-off, Celligenics, collaborated on a project to develop accessible and affordable therapies for chronic wounds such as diabetic foot ulcers which can lead to amputation.

Scientists from NTU's Lee Kong Chian School of Medicine, SRIS and Celligenics

Healthy Oat Cookies that Improve Blood Sugar Control

Nutriient, an A*STAR Singapore Institute of Food and Biotechnology Innovation (SIFBI) spin-off, developed a clinically validated, low glycaemic index (GI) cookie premix made from plant-based ingredients. The ingredients in this oat cookie can potentially reduce blood glucose levels and improve gut health, providing a healthier alternative to regular cookies.

*Low GI oat cookies made by Nutrient, an A*STAR spin-off*

CONTINUING TO SUPPORT NATIONAL EFFORTS TO FIGHT COVID-19 (2020 – 2021)

Launch of Infectious Diseases Labs

The A*STAR Infectious Diseases Labs (ID Labs) was set up to enhance Singapore's pandemic preparedness by bringing together scientists and fostering partnerships to drive cutting-edge translational ID research. This research covers new and effective technologies for detection, intervention and prevention of new and emerging pathogens.


New A*Star outfit aims to nip any emerging pathogen in the bud

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction.

▲ *ID Labs aims to nip any emerging pathogen in the bud before it transforms into an outbreak.*

Since its inception, A*STAR ID Labs has worked with public health care sectors and local partners for effective infectious diseases prevention, control and elimination.

- The Singapore COVID-19 Vaccine Response and Protection Study (SCOPE) seeks to understand how immunity wanes or improves over time for different people taking different vaccines. The findings will enable researchers to potentially develop preventive vaccines for future coronavirus pandemics. This study is done in collaboration with TTSH, CGH, NUH, Sengkang General Hospital, Ng Teng Fong General Hospital, Alexandra Health, Alexandra Hospital, National Healthcare Group, National University Polyclinics and NUS.
- A study to observe the immune responses to COVID-19 in vaccinated individuals in Singapore who had breakthrough infections was embarked upon with the National Centre for Infectious Diseases (NCID), National University Health System (NUHS) and Duke-NUS. Using longitudinal and integrated data from the same individuals, the committee was able to get a clearer picture on how to implement booster vaccine injections.
- A research collaboration agreement was formalised with NCID, A*STAR's BII and GIS to boost Singapore's genomic surveillance and COVID-19 research capabilities.

Study on Neutralising Antibodies

A study by A*STAR's Singapore Immunology Network (SIgN), Quantitative Biosciences Institute Coronavirus Research Group at University of California, San Francisco, University of Lyon and DSO National Laboratories collaborated on a study on COVID-19 neutralising antibodies. They discovered that some neutralising antibodies inhibit syncytia, while others drastically enhance it. The findings would provide for better treatment design.

Some antibodies may worsen Covid-19, study finds

Effect of these antibodies that prevent virus from infecting cells could impact treatment

has been linked to lung tissue dami-

Research Group at the University of California, San Francisco, University of Lyon and DSO National Laboratories, discovered that some neutralising antibodies inhibit syncytia, while others drastically was able to block interactions between the viral spike protein and ACE2 and inhibit syncytia formation, making it a viable candidate for Covid-19 treatment.

Dr Wang said that his team is

This is especially important, given the "ever-mutating nature" of the Sars-CoV-2 virus, he added.

Thus, pharmaceutical companies creating antibodies for Covid-19 treatment should also test their an-

comes. He adde still ongoing, w concerns.

If the clinical t ful, the antibody for review by th

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction.

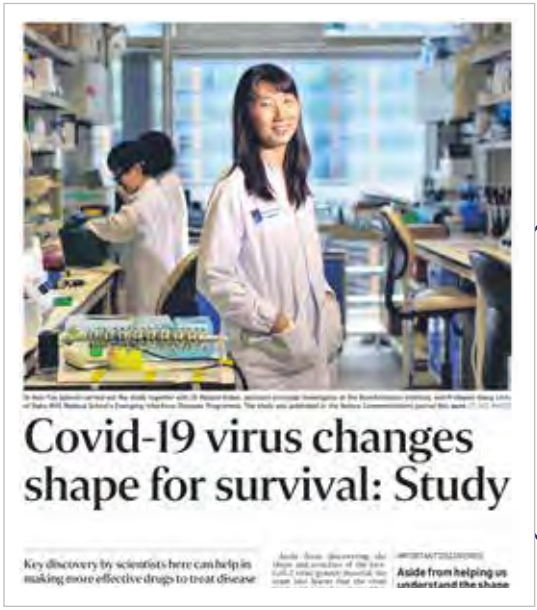
Studying the Impact of Mixing Different Vaccines

A*STAR, TTSH, Duke-NUS Medical School and KK Women's and Children's Hospital embarked on a study to observe the effects of different combinations of COVID-19 vaccines on the body's immune system. The study aims to define which prime-boost strategies of various COVID-19 vaccine formulations in Singapore induce a more durable response, and provide better immunogenicity against different variants of concern, in order to inform key policy strategies and decisions for the Singapore population.

▲ *The A*STAR team studying the effects of different combinations of COVID-19 vaccines on the body's immune system*

Virus Structure Study Helping to Produce More Effective Treatment Drugs

A team from A*STAR's GIS, BII, and Duke-NUS Medical School discovered how the shape and structure of the Sars-CoV-2 virus could interact with human cells to improve its survivability. This finding will aid in the development of more effective COVID-19 treatment drugs.



Covid-19 virus changes shape for survival: Study

Key discovery by scientists here can help in making more effective drugs to treat disease

Aside from helping us understand the shape

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction.

Tracking COVID-19 Using the GISAID Database

A team from A*STAR's BII has been helping to maintain the Global Initiative on Sharing All Influenza Data (GISAID) database, which has so far seen over nine million Sars-CoV-2 virus genomes being shared globally. GISAID played a significant role in detecting the Delta and Omicron variant in Singapore and is continuing to track the evolution of COVID-19.

▲ *The BII team posing with GISAID founder Peter Bogner (second from left) and GISAID Singapore team*

Deployment of Automated System at Vaccination Centres

A*STAR's ARTC and SIMTech collaborated with local systems integrator, Sysmatic Global, to develop an Automated Vaccine Inoculation Dispenser (AVID) system. By automating the extraction of vaccines from vials, and dispersing bubbles inside the syringes using a combination of robotic parts, smart sensors and digital technologies, healthcare workers can now be freed up for higher-value work. AVID has been deployed to at least seven vaccination centres in Singapore.

S'pore-made machine fills syringes with vaccine, eases nurses' workload

Clara Chong

Covid-19 vaccinations will now become a simpler, less tedious process for nurses, with the help of a machine that can automatically fill injection syringes.

The first of its kind in Singapore, the Automated Vaccine Inoculation Dispenser (Avid) system weighs less than 25kg and can fill six vaccine syringes in under five minutes.

It uses a combination of robotic parts, smart sensors and digital technologies.

The time taken for a nurse to manually fill six syringes varies and is affected by factors such as how experienced and how tired the nurse is.

The system reduces the workload of the nurses and removes the need for them to manually fill the syringes, allowing them to focus on caring and communicating with vaccine recipients.

It also reduces the possibility of human error, especially if the nurse is tired.

The machine is currently used to fill syringes with the Pfizer-BioNTech vaccine, but can be customised for other vaccines.

Avid has been deployed at seven vaccination centres islandwide, with the first at Senja-Cashew Community Club in early July.

Thomson Medical operates the vaccination centre there.

Nurse Nellie Tan, 47, with the Automated Vaccine Inoculation Dispenser system, which weighs less than 25kg and can fill six syringes in under five minutes. It has been deployed at seven vaccination centres islandwide. ST PHOTO: NG SOR LUAN

Vaccination centres might cater to at least 2,000 people a day, it was previously reported.

Avid was developed by researchers from the Agency for Science, Technology and Research's (A*Star) Advanced Remanufacturing and Technology Centre and Singapore Institute of Manufacturing Technology, in collaboration with local systems integrator Sysmatic Global.

Source: [The Straits Times] © SPH Media Limited. Permission required for reproduction

Developing a COVID-19 Antiviral Drug

A*STAR's Experimental Drug Development Centre (EDDC) discovered and validated several small molecules (protease inhibitors) that were effective against SARS-CoV-2 and other coronavirus strains. In January 2022, EDDC and Everest Medicines announced a global licensing agreement to develop, manufacture and commercialise EDDC's protease inhibitors as an oral antiviral therapy against COVID-19.

Stronghold Diagnostics Lab (SDL) Boosts National Capacity for COVID-19 Testing

The Stronghold Diagnostics Lab (SDL), which was established by A*STAR, NUHS and Temasek Foundation, contributed to Singapore's efforts in managing the spread of COVID-19 with its high-throughput, high-capacity testing capability.

Operator from SDL working on COVID-19 test samples

Joint Development of a Wastewater Testing Platform

The National Environment Agency (NEA), together with A*STAR and the Prime Minister's Office, jointly developed the Wastewater-Aliquoting-Valence-Engine (WAVE) platform to test wastewater samples for SARS-CoV-2 virus. By allowing wastewater to be tested in an efficient, safe and precise way in the laboratory, the growth of COVID-19 clusters can be stemmed more swiftly.

The WAVE platform tests wastewater samples for SARS-CoV-2 virus.

Using Technology to Control the Spread of COVID-19 in Enclosed Environments

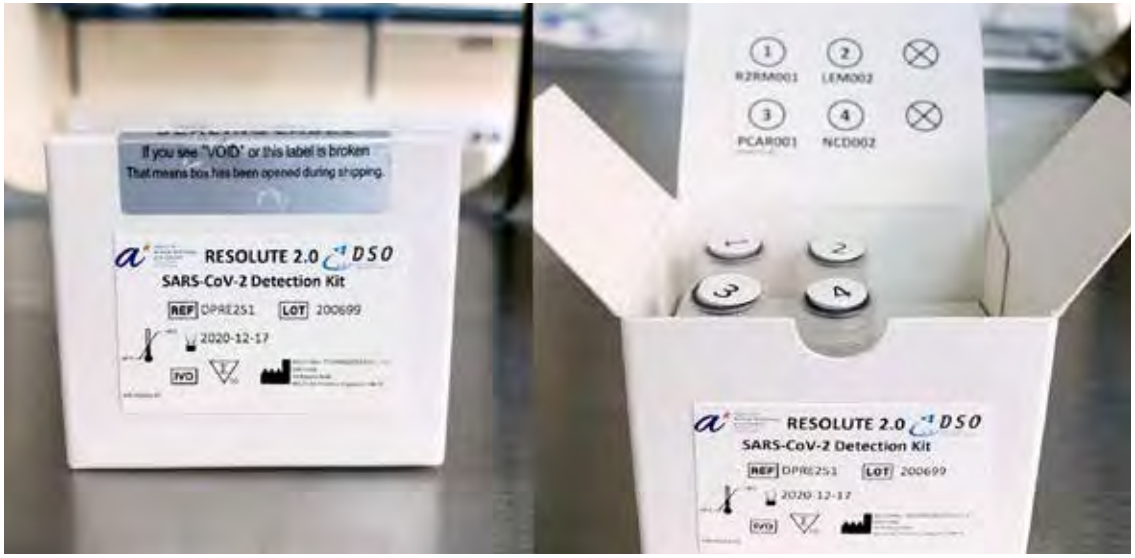
A*STAR's IMRE, IHPC and the Singapore Chinese Orchestra collaborated on a project to control the spread of COVID-19 in enclosed environments such as concert halls. After studying the movement of aerosols and droplets in the hall, ionisers were then deployed to pull positively charged aerosols, droplets and particulate matter towards the leaves of the plants to reduce COVID-19 transmission risk.

▲ *Experimental set-up showing small and large plant-based ioniser*

DEVELOPMENT OF COVID-19 DIAGNOSTIC TESTS

A*STAR and Local Medtech Firms Ramp Up Singapore's Testing Capability

Diagnostics Development (DxD) Hub and DSO National Laboratories developed RESOLUTE – a direct polymerase chain reaction (PCR) test kit that removes the need for RNA extraction from patient test samples, thereby minimising potential human errors and halving the time required to complete the test.



▲ *RESOLUTE Kit*

COVID-19 Kit That Detects Neutralising Antibodies

cPASS is the first serology test for neutralising antibodies that has been authorised by the US Food and Drug Administration authorisation. Jointly developed with Duke-NUS Medical School and Genscript, a leading global biotechnology company, A*STAR's DxD Hub validated the kit with clinical samples, and developed the manufacturing protocol and quality controls to secure its provisional authorisation by the HSA.

STRENGTHENING FOOD TECHNOLOGY AND INNOVATION CAPABILITIES IN SINGAPORE

We are focusing our R&D capabilities towards combatting food security issues and supporting Singapore's '30 by 30' food security goal.

$30 Million Boost to Accelerate Food Start-ups

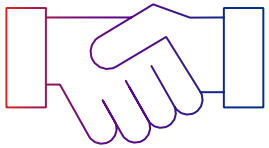
Temasek's Asia Sustainable Foods Platform and A*STAR have committed more than $30 million over the next three years to the Food Tech Innovation Centre (FTIC), to help food-tech start-ups with their product and process development, especially in alternative proteins.

> *"The project could address the needs of innovators, allowing them to serve global customers from Singapore while helping to strengthen the country's agri-food ecosystem."*
>
> **Mr Damian Chan**
> EDB Executive Vice-President

Developing Sustainable Food Systems with Microalgae-based Proteins

A*STAR's SIFBI, NUS and Singapore-Eidgenössische Technische Hochschule (ETH) Centre, together with industry partners Bühler Group, Givaudan, Nestlé, Planted Foods, Sophie's BioNutrients and Singapore Food Agency (SFA) embarked on a research project to sustainably produce microalgae-based protein and innovate food concepts that will better meet consumers' preferences.

SIFBI is working with NUS, Singapore-ETH Centre and industry partners to develop microalgae that could be used as an alternative, sustainable, urban-grown protein source.



Advancing Singapore's Agri-Food Industry

A*STAR's SIFBI and Agilent Technologies Inc. signed a collaboration agreement to advance food research, which will drive innovation in food, nutrition, ingredients, industrial biotechnology and related applications.

Improving the Protein Content of Plant-based Products

Local start-up, Float Foods, leveraged the capabilities of A*STAR's SIFBI to optimise the protein content and stability of egg proteins in their plant-based products. The shelf-life of Float Foods' products has now been extended by up to eight weeks in chilled conditions.

Acceleration of Cultivated Fish Technology to Serve the Mass Market

A*STAR's Bioprocessing Technology Institute (BTI) and Avant inked a research collaboration to scale-up production of cultivated fish. This collaboration paves the way for cost effective food grade production that meets the demand for sustainable alternatives to traditional livestock farming.

▲ *Cultivated fish burger demonstration by Avant in November 2020*

SHAPING A SUSTAINABLE FUTURE FOR SINGAPORE

A New Institute to Support Singapore's Sustainability Goals

The Institute of Sustainability for Chemicals, Energy and Environment ($ISCE^2$) aims to advance R&D in areas such as low-carbon technologies, carbon life cycle assessment, sustainable materials and green manufacturing processes using the latest digitalisation and automation tools. $ISCE^2$ is a re-organisation of the former Institute of Chemical and Engineering Sciences. It will partner academics, public agencies and the energy, chemicals and pharmaceutical industries to achieve Singapore's sustainability goals, such as Singapore Green Plan and Zero Waste Masterplan.

> *$ISCE^2$ will advance research areas such as carbon capture and utilisation, low-carbon hydrogen, carbon life-cycle accounting, and synthetic biology to pave the way for alternative green materials, products and processes, to support Singapore's sustainability agenda.*
>
> **Mr Gan Kim Yong**
> Minister for Trade and Industry

▲ *Established by A*STAR in 2022, $ISCE^2$ supports Singapore's sustainability goals.*

Coastal Sustainability Alliance (CSA) for a Next-Gen Maritime Ecosystem

CSA which is made up of A*STAR, GenPlus, Jurong Port Singapore, Sea Forrest, Technology Centre for Offshore and Marine, Singapore, and TES aims to support Singapore's next-generation maritime ecosystem by accelerating the decarbonisation, electrification and advancement of energy-efficient logistics and engineering solutions by 2030.

▲ *Launch of Coastal Sustainability Alliance (CSA), graced by Guest-of-Honour, Dr Tan See Leng, Minister for Manpower and Second Minister for Trade and Industry.*

Testbed Facility for Emerging Carbon Capture and Utilisation (CCU) Technologies

A*STAR, the Economic Development Board, Jurong Town Corporation (JTC) and 10 other ecosystem partners signed an MoU to formalise the Carbon Capture and Utilisation Translational Testbed (CCUTT), aimed at helping local industries on their decarbonisation journey. Consisting of public research institutes and private enterprises, CCUTT will assist companies in rapidly piloting, adopting and scaling up new CCU technologies, as well as accelerate CCU and hydrogen technology developments.

▲ *CCUTT MoU Signing Ceremony at the Industrial Transformation Asia-Pacific (ITAP) on 23 November 2021.*

Collaboration to Develop and Implement Green Compass – a Sustainability Assessment Tool

A*STAR's SIMTech collaborated with JTC and TUV SUD to develop a self-assessment tool for businesses to improve their environment sustainability efforts. Green Compass is aimed at improving resource efficiency, enhancing brand reputation and securing future earnings through enhancing stakeholder trust and staying on top of sustainability regulations and trends.

▲ *A*STAR SIMTech, JTC, and TÜV SÜD signed an agreement to develop a Green Compass initiative that offers a set of software assessment tools, methodologies, and training workshops and courses to help businesses across sectors transition to more sustainable and resilient business models.*

New Centre Established to Develop Next Generation AI Technologies

The A*STAR Centre for Frontier AI Research (CFAR) was formed to advance use-inspired basic research in AI within the A*STAR scientific community and the wider research ecosystem. CFAR focuses on developing next generation AI technologies for Sustainable AI, Resilient & Safe AI and Artificial General Intelligence.

CONTRIBUTING TO A SAFE AND SECURE HOMELAND

Partnering Public Officers to Ensure Public Health and Safety

A*STAR's Institute for Infocomm Research (I^2R) continued its collaboration with Home Team Science and Technology Agency (HTX) to develop autonomous ground robots to enhance public safety and security. An enhanced M.A.T.A.R 4.0 was deployed at National Day Parades 2021 and 2022 to augment on-the-ground operational efficiency and project police presence.

I^2R and HTX also trialed the use of patrolling robot Xavier, at Toa Payoh in September 2021 in a joint project involving the National Environment Agency, Land Transport Authority, Singapore Food Agency and Housing & Development Board. The deployment of Xavier could support the work of public officers in deterring undesirable social behaviours such as smoking in prohibited areas and improperly parked bicycles.

I^2R is also collaborating with HTX and ST Engineering to develop a smaller indoor version of the M.A.T.A.R robot to assist officers at the checkpoints in escort duties, as well as with HTX and KLASS Engineering to enable a four-legged robotic dog, Rover-X, to autonomously climb stairs and navigate in uneven outdoor terrain.

▲ *Xavier's trial deployment at Toa Payoh*

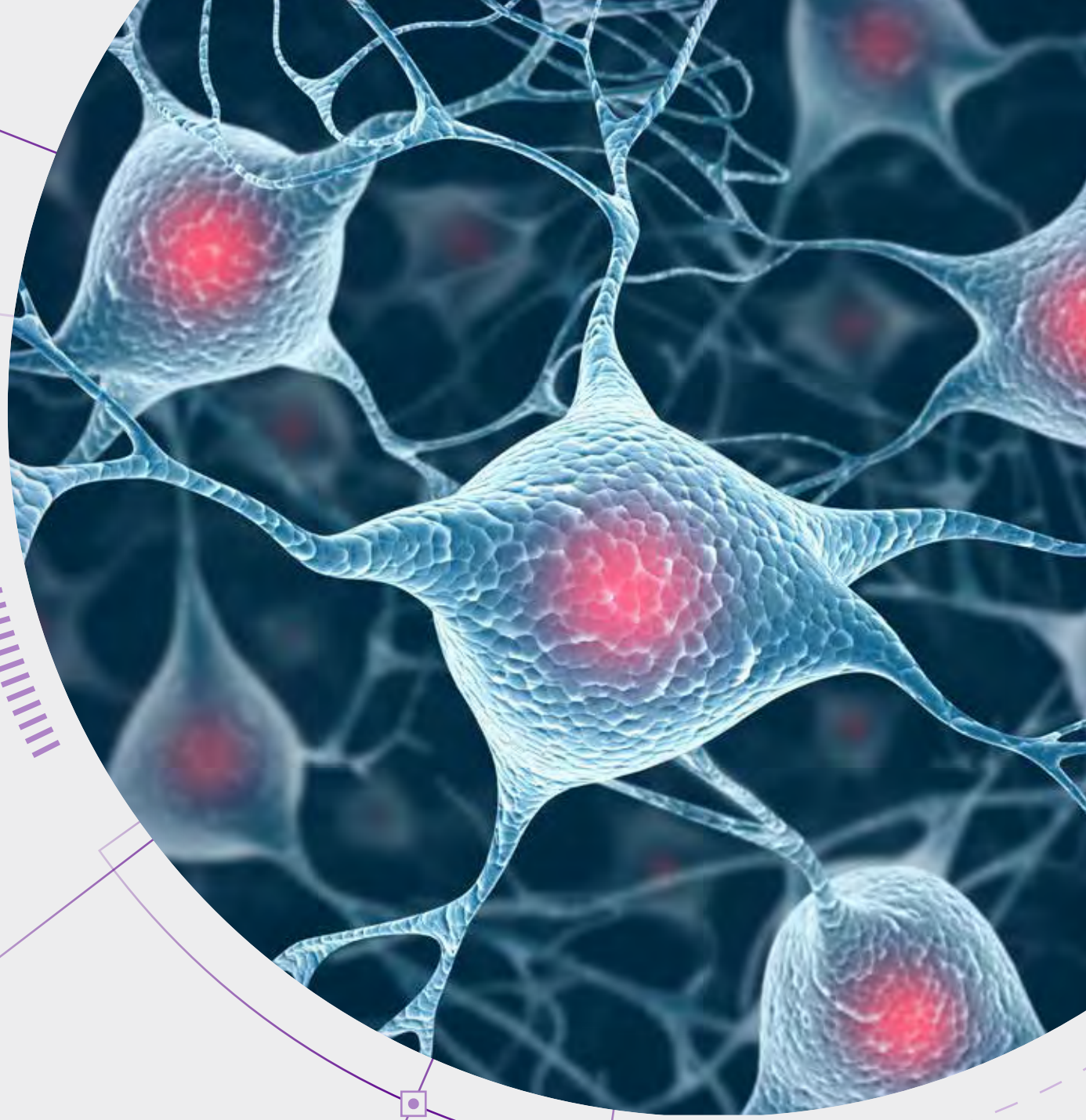
Developing Multimodal Sense-making Capability to Improve Safety and Security

A*STAR's I^2R worked with ST Engineering to develop an AI system for analysing publicly-uploaded videos and images relating to fire safety and security. I^2R delivered a visual sense-making system that localises fires, estimates its characteristics (intensity and nature of combustion source), and identifies hazardous objects. In addition, I^2R developed AI features to detect riot incident, mass protest and other crowded situations.

KEY ACHIEVEMENTS

DEEPENING USE-INSPIRED BASIC RESEARCH ▸▸

As one of the world-leading public research organisations, A*STAR is leveraging use-inspired basic science to create new knowledge and build capabilities. It conducts R&D on a range of outcome-driven projects with the industry and public agencies. It uses research as an innovation engine to grow the economy and secure our future. Here are some highlights of the impactful science.

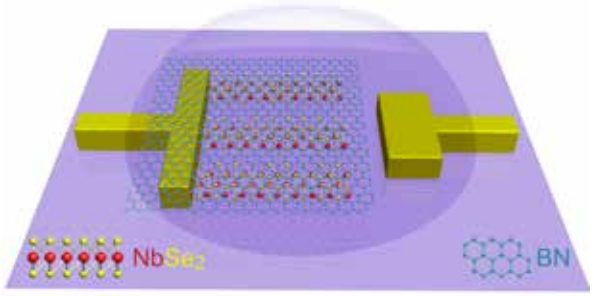


▸ *Neurons in the brain*

PHYSICAL SCIENCE AND ENGINEERING

Electrostatically Tunable Near-Infrared Plasmonic Resonances in Solution-Processed Atomically Thin $NbSe_2$

Identification of 2D materials as promising candidates to extend electrostatically tunable plasmonics to near-infrared range, which has applications in sensing, telecommunication, energy harvesting and more.



Teng Jing Hua and Zhao Meng
IMRE

Electrostatically Tunable Near-Infrared Plasmonic Resonances in Solution-Processed Atomically Thin $NbSe_2$

Advanced Materials

Precise Forecasting of a Machine's Remaining Useful Life (RUL)

A*STAR researchers proposed a method (contrastive adversarial domain adaptation) that outperforms the current state-of-the-art in terms of cross-domain RUL prediction in machines. This can help to further reduce machine maintenance cost, increase availability and prevent breakdowns.

Li Xiaoli
I^2R

Contrastive Adversarial Domain Adaptation for Machine Remaining Useful Life Prediction

IEEE Transactions on Industrial Informatics

Anticipating Human Actions by Correlating Past with the Future

The novel framework could help computers predict human actions more accurately.

Basura Fernando
IHPC

Anticipating human actions by correlating past with the future with Jaccard similarity measures

Conference on Computer Vision and Pattern Recognition (CVPR)

Integrating Recyclable Polymers into Thermoelectric Devices for Green Electronics

A*STAR researchers demonstrated the use of a recyclable polymer, vitrimer, to tackle the challenge of separating components during recycling of electronic devices.

Li Zibiao
IMRE, $ISCE^2$

Zheng Jie
$ISCE^2$

Integrating recyclable polymers into thermoelectric devices for green electronics

Journal of Materials Chemistry A

Discovery of Electromechanically Tunable Frequency-agile Transmission Filters for Terahertz Applications

The electromechanically reconfigurable complementary metadevice for spectral tuning of narrowband terahertz transmission is highly versatile in design and consumes low power. Tunable transmission filters are essential for various key terahertz applications like channel selectors in high-speed wireless communication systems and more.

Wang Nan and Prakesh Pitchappa
IME

Electromechanically Tunable Frequency-agile Metamaterial Bandpass Filters for Terahertz Waves

Advanced Optical Materials

Enhancing the Ultimate Strength and Ductility of High-Entropy Alloys (HEAs)

This study reveals the role of short-range ordering in influencing the ultimate strength and ductility of HEAs, and provides guidelines for designing HEAs with high-performance mechanical properties for engineering applications.

Zhang Yong Wei and Chen Shuai
IHPC

Simultaneously enhancing the ultimate strength and ductility of high-entropy alloys via short-range ordering

Nature Communications

Chitosan-derived Porous N-Doped Carbon as a Promising Support for Ru Catalysts in One-pot Conversion of Cellobiose to Hexitol

A*STAR researchers revealed that renewable material chitosan can be used as a promising high-surface-area N-containing carbon support for noble metal catalysts (Ru). This can be applied in a wide range of biomass hydrogenation conversions for sustainable production of fuels and chemicals.

Liu Yan and Xin Xiao
ISCE²

Chitosan-derived porous N-doped carbon as a promising support for Ru catalysts in one-pot conversion of cellobiose to hexitol

ACS Sustainable Chemistry & Engineering

Halide Salt-Catalyzed Crosslinked Polyurethanes for Supercapacitor Gel Electrolyte Applications

Proof-of-concept study revealed that polymers suitable for gel electrolyte applications can be synthesised using very cheap and common salts as catalysts. The potential for these non-toxic salts to replace traditionally-used highly-toxic tin catalysts for synthesis of these polymers can reduce the environmental footprint of supercapacitor devices.

Jason Lim, Derrick Fam, Chien Sheau Wei
IMRE

Halide Salt-Catalyzed Crosslinked Polyurethanes for Supercapacitor Gel Electrolyte Applications

ChemSusChem

BIOMEDICAL SCIENCE

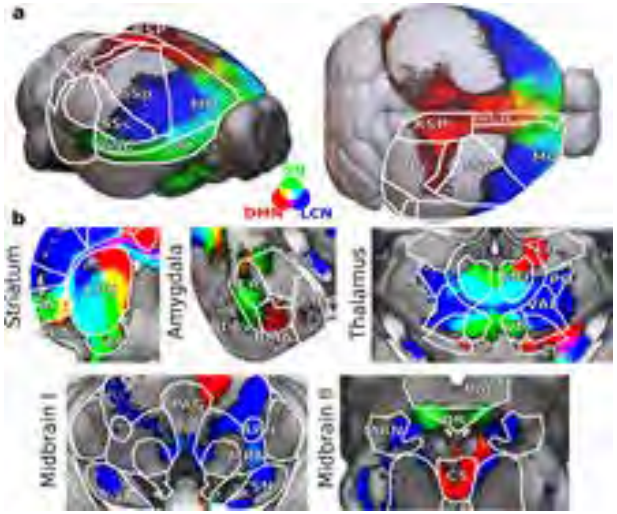
A Triple-Network Organisation for The Mouse Brain

The triple-network model of psychopathology is a framework that explains the functional and structural neuroimaging phenotypes of neurological disorders. A*STAR researchers applied the framework to a mouse model and realised that model predictions were also shown to apply in a mouse model for depression. This allows them to humanise the mouse brain networks and use the mouse for treatments testing to help develop better treatment solutions for humans.

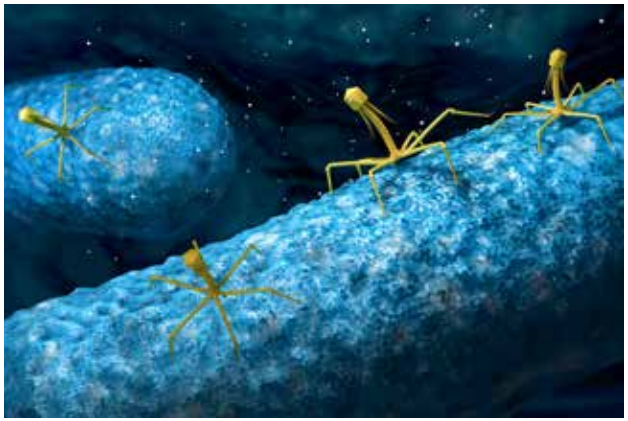
Yeow Ling Yun and Joanes Grandjean
IBB

A triple-network organization for the mouse brain

Molecular Psychiatry



A Widespread Pathway for Substitution of Adenine by Diaminopurine in Phage Genomes



We know that the four bases adenine (A), cytosine (C), guanine (G), and thymine (T) make up the DNA while interestingly, some viruses swap in a fifth base, Diaminopurine (Z) and it can completely replace A. This study revealed enzymes that support Z-genome synthesis are widely found in phages and that this biosynthetic system in Z-DNA production has the potential for a range of applications, including DNA-based data storage and DNA origami for the construction of nanorobots.

Wei Yifeng and Zhao Huimin
SIFBI

A widespread pathway for substitution of adenine by diaminopurine in phage genomes

Science

Atopic Dermatitis (AD) Microbiomes Stratify into Ecologic Dermotypes Enabling Microbial Virulence and Disease Severity

Analysis of skin microbiomes of AD patients uncovered distinct clusters of microbial profiles associated with AD, highlighting a mechanism for ongoing inflammation.

John Common
A*SRL

Niranjan Nagarajan
GIS

Atopic dermatitis microbiomes stratify into ecologic dermotypes enabling microbial virulence and disease severity

Journal of Allergy and Clinical Immunology

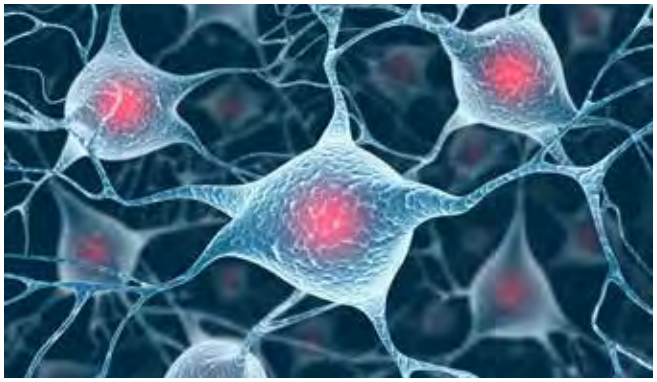
A Cluster of Neurons in The Brain May Be Causing Overeating

A*STAR researchers have identified a network of neurons in the brain that drives overeating in response to environmental factors, rather than genuine hunger. These findings could potentially change how we view and tackle health issues.

Fu Yu
IMCB

A neural circuit for excessive feeding driven by environmental context in mice

Nature Neuroscience



Potential Treatment for Inflammation-Associated Diseases

Discovery of a biomarker which could potentially be used as a therapeutic target for inflammatory bowel disease and other inflammation-associated diseases.

Vinay Tergaonkar, Lele Wu and Semih Can Akincilar
IMCB

NAIL: An evolutionarily conserved lncRNA essential for licensing coordinated activation of p38 and NFκB in colitis

Gut

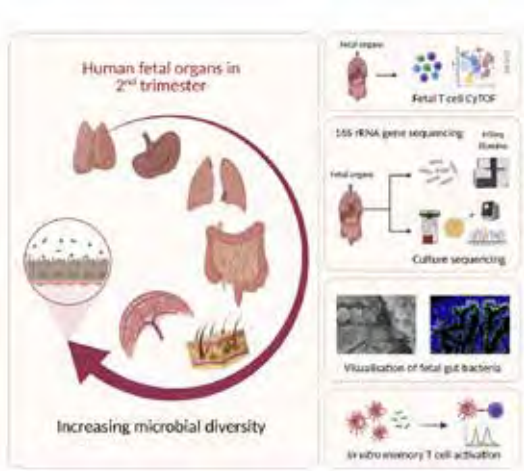
Live Bacterial Strains in Fetal Tissues Give Babies an Immunity Boost

Studying how early contact with microbes in the womb could boost immune development in the developing foetus.

Florent Ginhoux and Archita Mishra
SIgN

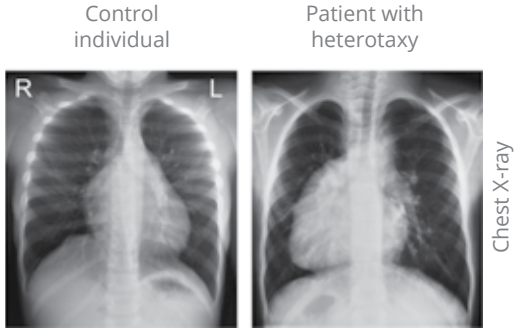
Microbial exposure during early human development primes fetal immune cells

Cell



Discovery of Novel Gene that Governs Left-Right Asymmetry within the Human Body

The discovery by A*STAR as well as clinicians from six different countries has helped diagnose congenital heart defects and heterotaxy syndromes, which affect 1 in 10,000 live births.



Chest X-ray of a control individual (left), with his heart pointing to the left (L) compared to the chest X-ray of a patient with heterotaxy (right) that shows his heart inversely positioned to the right (R)

Emmanuelle Szenker-Ravi
GIS

Bruno Reversade
GIS, IMCB

Discovery of a genetic module essential for assigning left–right asymmetry in humans and ancestral vertebrates

Nature Genetics

Potential of Thermogel to be Used for Retina Recovery

This study characterised thermogel properties, expanding the scope of polymer architectures suitable for intraocular therapeutic applications in the living body. For example, in retina recovery after eye surgery.

Su Xinyi
IMCB

Loh Xian Jun
IMRE

High molecular weight hyper-branched PCL-based thermogelling vitreous endotamponades

Biomaterials

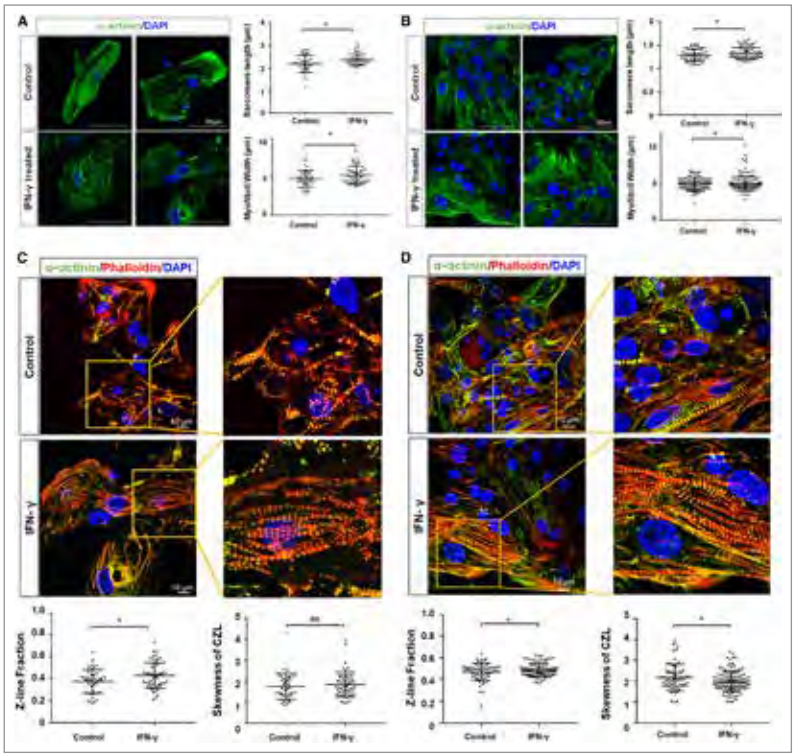
Upregulation of the JAK-STAT Pathway Promotes Maturation of Human Heart Cells

A*STAR researchers uncovered the role of JAK-STAT signaling in promoting the maturation of stem cell-derived heart cells, an important step for the application in disease modeling, drug discovery and cell-based therapy in cardiac regeneration.

Beatrice Ho, Ng Shi Yan, Soh Boon Seng
IMCB

Upregulation of the JAK-STAT pathway promotes maturation of human embryonic stem cell-derived cardiomyocytes

Stem Cell Reports



Improved sarcomeric structure in IFN-γ-treated H7- and ES03-derived CMs

KEY ACHIEVEMENTS

NURTURING TOP TALENT FOR THE LOCAL R&D ECOSYSTEM ▸▸

At A*STAR, we are committed to ensuring a pipeline of ready scientific talent for our local R&D ecosystem. We believe that this is an essential part of maintaining Singapore's status as one of the world's foremost innovative economies.

▸ *From left: Prof Chen Xiaodong, Prof Sir Peter Gluckman and Dr Sarah Luo, recipients of the President's Science and Technology Medal, President's Science Award and Young Scientist Award respectively.*

INDUSTRY AWARDS

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

T-Up Excellence Award Winners

Mr Lai Szu Cheng
Principal Specialist, IMRE

Mr Lai Szu Cheng was seconded to TechnoDigm Innovation where he helped to develop robust ultraviolet sensing solutions and enhanced the performance of their existing UV curing products. This enabled TechnoDigm to meet market demands and be more competitive.

Mr Lim Eng Thiam
Senior Research Engineer, I²R

Mr Lim Eng Thiam was seconded to Soundeye to help design and develop a sound recognition platform using AI. As a result, SoundEye has developed and commercialised two new sound surveillance systems, DONUT and PUCK, for use in emergency / home monitoring and security surveillance applications.

Mr Labastida Michael Entendez
Senior Research Engineer, ARTC

Mr Labastida Michael Entendez was seconded to Arcstone where he developed a software, "arc.net". The software enables Arcstone to leverage data to expand their range of manufacturing execution system solutions and extend the service to their manufacturing clients, thereby adding value to the whole supply chain.

T-Up Emerging Talent Award Winner

Mr Jiang Ting Ying
Senior Research Engineer, SIMTech

Mr Jiang Ting Ying was seconded to Phaos Technology to develop three modular software solutions for the company's microscopy project, helping to improve their product capabilities.

2021 Ten Outstanding Young Persons of Singapore (TOYP) Awards

The TYOP recognises outstanding young people in Singapore who have excelled in their respective fields and made a positive difference to society.

Dr Su Xinyi, Senior Principal Investigator, Division Director at Institute of Molecular and Cell Biology, Assistant Professor and Consultant Ophthalmologist, NUS, and Co-Founder of Vitreogel Innovations, was conferred the 2021 Honoree award (Medical Innovation category).

NATIONAL AWARDS

2021 Public Sector Transformation (COVID) Award

One Public Service Award / Commissioned by the Ministry of Health, A*STAR, together with NUHS and Temasek Foundation, established Stronghold Diagnostics Lab (SDL) in July 2020 to support national efforts in managing the spread of COVID-19. Since its inception, SDL has handled over two million swabs and boosted COVID-19 PCR testing capacity with other laboratories. Also supporting the initiative was ALPS Healthcare and Testing Ops Centre.

▲ *A*STAR, as part of the multi-agency team, received the award on supporting national efforts in managing the spread of COVID-19.*

Dare to Do Award / A team from A*STAR's BTI and Health Sciences Authority developed analytical assays for different vaccine product types, and implemented them for investigational testing of vaccine batches. They also helped to train a talent pool to boost vaccine testing capabilities.

▶ *Dr Andre Choo, Deputy Executive Director at Bioprocessing Technology Institute (centre) and Executive Director (Resource Allocation and Optimisation) at BMRC, receiving the award from Deputy Prime Minister, Mr Lawrence Wong (right).*

Agility Award / A*STAR researchers partnered local textile manufacturer Ramatex to develop a reusable face mask that had the merits of medical masks, when global supply chains were disrupted and COVID-19 cases were increasing in early 2020. More than 10 million of these masks have since been produced.

▲ *Mr Jonathan Goh, Principal Research Engineer and Deputy Director, SIMTech (left) receiving the Agility award.*

Exemplary Innovator Award / DxD Hub and DSO National Laboratories developed the PCR diagnostics kit, RESOLUTE, to test for SARS-CoV-2 virus in nasopharyngeal swab samples, during the early phase of the COVID-19 pandemic. RESOLUTE has the same accuracy and sensitivity as traditional PCR test kits. Its compatibility with different clinical samples and PCR instruments also allowed staff with minimal training to administer testing. RESOLUTE is currently used by both public and private testing laboratories and has been instrumental in facilitating the reopening of our borders.

▲ *Dr Weng Ruifen, Deputy Chief Executive Officer, DxD Hub (right) receiving the Exemplary Innovator award.*

The President's Science and Technology Medal (PSTM)

Professor Sir Peter Gluckman
Chief Scientific Officer, SICS

Professor Sir Peter Gluckman was awarded the PSTM for his outstanding leadership in advancing health, clinical and biomedical sciences research. His leadership has helped to strengthen developmental and early life research, and enhanced Singapore's human health and R&D capabilities.

The President's Science Award (PSA)

Professor Chen Xiaodong
Scientific Director, IMRE

Professor Chen Xiaodong was awarded the PSA for his outstanding contribution to advanced materials research in soft bioelectronics. His work deals with digitising biological senses and extending human sensing capabilities, as well as their potential applications in advanced manufacturing and healthcare wearables.

Young Scientist Awards (YSA)

Dr Sarah Luo
Principal Investigator, IMCB

Dr Sarah Luo discovered that a group of brain cells called tuberal nucleus, and environmental factors were potentially affecting feeding behaviour. Her findings could potentially change the way we approach health issues such as diabetes and obesity.

National Medical Excellence Award Winner

Dr Lisa Ng
Executive Director, BMRC Council and ID Labs

Dr Lisa Ng was part of the COVID-19 Research Workgroup that won a national award for their role in the pandemic response in Singapore and globally.

OTHER AWARDS AND RECOGNITIONS

A*STAR Scientists on Clarivate's Highly Cited Researchers 2021 List

According to Clarivate, A*STAR's researchers rank among the world's most influential in fields such as immunology, molecular biology and genetics, as well as in cross-disciplinary work. They are a testament to our multi-disciplinary approach, and strong collaborative research and innovation environment. Scientists on the list include:*

01 Dr Chen Jinmiao
Principal Investigator, SIgN

02 Dr Ng Lai Guan
Principal Investigator, SIgN

03 Dr Lim Sai Kiang
Research Director, IMCB

04 Dr Lai Ruenn Chai
Research Scientist, IMCB

05 Dr Liu Zhaolin
Senior Scientist, IMRE

06 Prof Michael Meaney
Director, SICS

07 Dr Seh Zhi Wei
Senior Scientist, IMRE

08 Prof Zhang Yong-Wei
Deputy Executive Director, IHPC

09 Dr Subhra Kumar Biswas
Principal Investigator, SIgN

10 Dr Florent Ginhoux
Senior Principal Investigator, SIgN

11 Prof Nick Barker
Research Director, IMCB

12 Dr Zhang Lili
Senior Scientist, ICES

13 Prof Laurent Renia
Senior Fellow, ID Labs


01


02


03


04


05


06


07


08


09


10


11


12


13

** Clarivate's Highly Cited Researchers 2021 list identifies influential researchers based on their publication of highly cited papers over the past decade. Their names are drawn from the top one per cent of publications in the Web of Science citation index.*

Singapore 100 Women in Tech (SG100WIT) 2021

*The SG100WIT initiative celebrates women who have made significant contributions to tech in Singapore. In 2021, the following women in A*STAR were recognised:*

01 **Dr Nancy Chen**
Senior Scientist, I²R

02 **Dr Pavitra Krishnaswamy**
Senior Scientist, I²R

03 **Dr Liu Jinyue**
Research Fellow, GIS

04 **Dr Nai Mui Ling Sharon**
Senior Scientist, SIMTech

05 **Dr Yang Le**
Scientist, IMRE


01


02


03


04


05

Underwriters Laboratories—ASEAN-U.S. Prize for Women 2021

Dr Li Hongying
Senior Scientist, IHPC

Dr Li Hongying won the Underwriters Laboratories-ASEAN-U.S. Prize for Women 2021 in the Mid-career Scientist category for her efforts in designing an internationally recognised ballast water treatment system, which protects marine life from water pollution. The system also predicts airborne droplet dispersal rates to estimate COVID-19 transmission risks.

Institute of Electrical and Electronics Engineers (IEEE) Fellow 2022

Professor Ivor Tsang
AI Fellow, Principal Scientist, IHPC
Director, CFAR

Prof Ivor Tsang was awarded the 2022 IEEE fellow for his contributions towards large-scale machine learning and transfer learning.

Fellow of the Institution of Engineering and Technology (FIET)

Dr Jason Png
Senior Scientist and Department Director, IHPC

Dr Jason Png was conferred the IET fellowship in recognition of his significant contributions, achievements and prof essionalism in engineering areas relevant to the Institute of Engineering and Technology (IET).

Elected Fellow of the Society of Photographic Instrumentation Engineers (SPIE)

Dr Teng Jinghua
Principal Scientist, IMRE

Dr Teng Jinghua, Principal Scientist at IHPC was the only Singaporean in a group of 58 new Fellows appointed by SPIE. Fellows are members of distinction who have made significant scientific and technical contributions in the multi-disciplinary fields of optics, photonics and imaging, as well as to SPIE.

National Research Foundation (NRF) Fellowship awardees

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

Dr Lum Yanwei
Assistant Professor, NUS
Scientist, IMRE

For "Developing innovative toolkits for elucidating the fundamentals of electrochemical CO_2-to-chemicals conversion".

Dr Basura Fernando Chinath
Scientist, IHPC

For "Learning why we do what we do through abductive and deductive understanding of human action using Neurosymbolic AI".

National Research Foundation (NRF) Investigatorship awardees

*Two A*STAR researchers were awarded the NRF Investigatorship, which provides opportunities for mid-career researchers and excellent Principal Investigators with a track record of research achievements, to continue pursuing ground-breaking, high-risk research.*

Dr Fu Yu
Head of Brain Plasticity Group, IMCB

For "Investigating Neuronal Mechanisms of Obesity and its Treatment by Bariatric Surgery for Future Therapeutic Strategy".

Professor Loh Xian Jun
Executive Director, IMRE

For "Thermogels for Therapeutic Applications".

A*STAR Scholarship Awards Ceremony 2021

In 2021, a total of 69 A*STAR scholarships were presented. First launched in July 2001 to develop local PhD talent in Singapore, the annual awards ceremony recognises and welcomes newly awarded scholars into the A*STAR family.

▶ *Minister for Trade and Industry, Mr Gan Kim Yong, A*STAR senior management and newly-minted scholars at the virtual SAC 2021 Award Ceremony.*

SIGNIFICANT GRANTS

Wellcome Leap R3 Programme

A team of researchers from A*STAR's GIS, IBB, and NUS Yong Loo Lin School of Medicine was awarded a contract from this prestigious programme to develop next generation messenger RNA (mRNA) technology.

National Research Foundation Competitive Research Programme

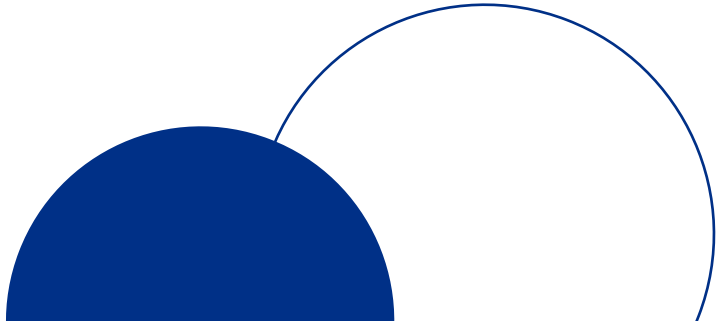
The programme funds use-inspired basic research projects and fosters multidisciplinary teams to conduct cutting-edge research projects that helps to address national and societal needs. Five A*STAR researchers were awarded the highly competitive grant.

Full list of awardees

Manufacturing, Trade and Connectivity Individual Research Grant & Young Individual Research Grant

Seven A*STAR researchers were awarded for both grants which support novel and fresh R&D investigator-led ideas.

Full list of awardees



National Medical Research Council (NMRC) Individual Research Grant and Young Individual Research Grant

A total of 24 A*STAR researchers were awarded the funds from NMRC to nurture basic, translational and clinical research that are relevant to human health and potential.

Full list of awardees

Quantum Engineering Programme 2.0

Eight A*STAR researchers were awarded funding under this national programme to develop quantum science and technology across four pillars: communication and security, computing, sensors and foundry.

Full list of awardees

Industry Alignment Fund – Pre-positioning Programme

The grant aims to develop industry-ready capabilities to deepen the alignment of public sector research, as well as multidisciplinary and integrated programmes with early industry involvement. Four A*STAR teams were awarded the grant.

Full list of awardees

Industry Alignment Fund – Industry Collaboration Project

Seven A*STAR teams were awarded the grant to support and foster industry-relevant public sector R&D efforts, in collaboration with industries and with a line of sight to potential economic outcomes.

Full list of awardees

A*STAR Researchers also received the following grants to advance AI technologies and innovation

Grants	Lead Principal Investigator	Project
AI Singapore Challenge (Open-Theme) Funding Scheme	**Prof Liu Yong** IHPC	RAPIER – Radiology Pathology Information Exchange Resource
AI Research Grant Call	**Zhang Mengmi** I²R	Memory-efficient Online Continuous Object Recognition on Video Streams
	Li Xiaoli I²R	Self-aware Continuously Learning Models
AI Singapore 100 Experiments for Research	**Dr Mile Šikić** GIS	AI-driven de novo diploid assembler

Low-Carbon Energy Research Funding Initiative (LCER FI)

The initiative aims to develop low-carbon energy technologies in the domains of hydrogen and carbon capture, utilisation, and storage, to support the decarbonisation of the power and industry sectors.

Miniature H_2 Leakage and Purity Sensors for Downstream H_2 Use

Lead Principal Investigator:
Dr Doris Ng
IME

Alternative Sand from Carbon Dioxide and Waste Materials

Lead Principal Investigator:
Dr Bu Jie
ICES

National Robotics Programme - Robotics Domain Specific (RDS)

The programme co-funds projects with public agencies in Healthcare, Built Environment, and Environmental Services to innovate robotic solutions for their problem statements.

System for Remotely Operated Earthworks

Lead Principal Investigator:
Mr Alberto De San Bernabé Clemente
ARTC

MTC Programmatic Funding

The initiative seeks to support long term, capability-building and high-potential projects to further economic outcomes for Singapore.

Nanoantenna Light Emitting Devices (NLED)

Lead Principal Investigator:
Dr Arseniy I. Kuznetsov
IMRE

Engaging The Community

*A*STAR team giving back to the society*

CELEBRATING 30 YEARS OF INNOVATION

A*STAR celebrated our 30th anniversary in 2021. Together with our partners and collaborators, we have built a vibrant research and innovation ecosystem. We recognise the importance of science, technology and innovation for the years ahead and we will continue to pursue innovation and scientific excellence to create growth and enhance lives.

BUILDING TIES IN THE COMMUNITY

Community Chest's Christmas On "A Great Street" Light-Up Event

Our Corporate Social Responsibility (CSR) team raised more than $10,000 for the event. All the proceeds and donations would be channelled to support over 100 social service agencies and 200 programmes supported by Community Chest in Singapore.

"Adopt A Bag" Donation Campaign

As part of SG Cares Giving Week, A*STAR's CSR committee and volunteers partnered the SG Cares Volunteer Centre @ Geylang to pack and distribute $14,000 worth of grocery bags containing daily necessities and food items for the beneficiaries residing in the area.

Community Chest Awards 2021

We received the Charity Bronze award, which is presented to organisations and individuals who have donated amounts ranging between S$50,000 and S$99,999.

Constructing DIY Air Purifiers at Singapore Children's Society

Our Aerosols & Airflow team from the Institute of Materials Research and Engineering and Institute of High Performance Computing visited the residents of Sunbeam Place @ Singapore Children's Society to teach them how to make DIY air purifiers from easily available materials such as plastic bags, surgical masks and fan mesh.

Key Performance Indicators

RIE 2025 KPIs	A*STAR Achievement in FY2021	RIE 2025 Target
Industry R&D Projects*	1,866	6,500
Industry R&D Spending (S$ mil)	481.5	1,200
Licensing Revenue (S$ mil)	17	24
Number of successful Spin-offs	12	40
Field Weighted Citation Impact (FWCI)	1.5	1.5

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

Agency for Science, Technology and Research
SINGAPORE

ORGANISATION DETAILS

Board Secretary
Ms Adeline Tung, Director, Planning and Policy Division,
Joint Planning Hub, A*STAR

Address
Agency for Science, Technology and Research,
1 Fusionopolis Way, #21-10 Connexis North, Singapore 138632

Telephone
6826 6174

Email
Adeline_Tung@hq.a-star.edu.sg