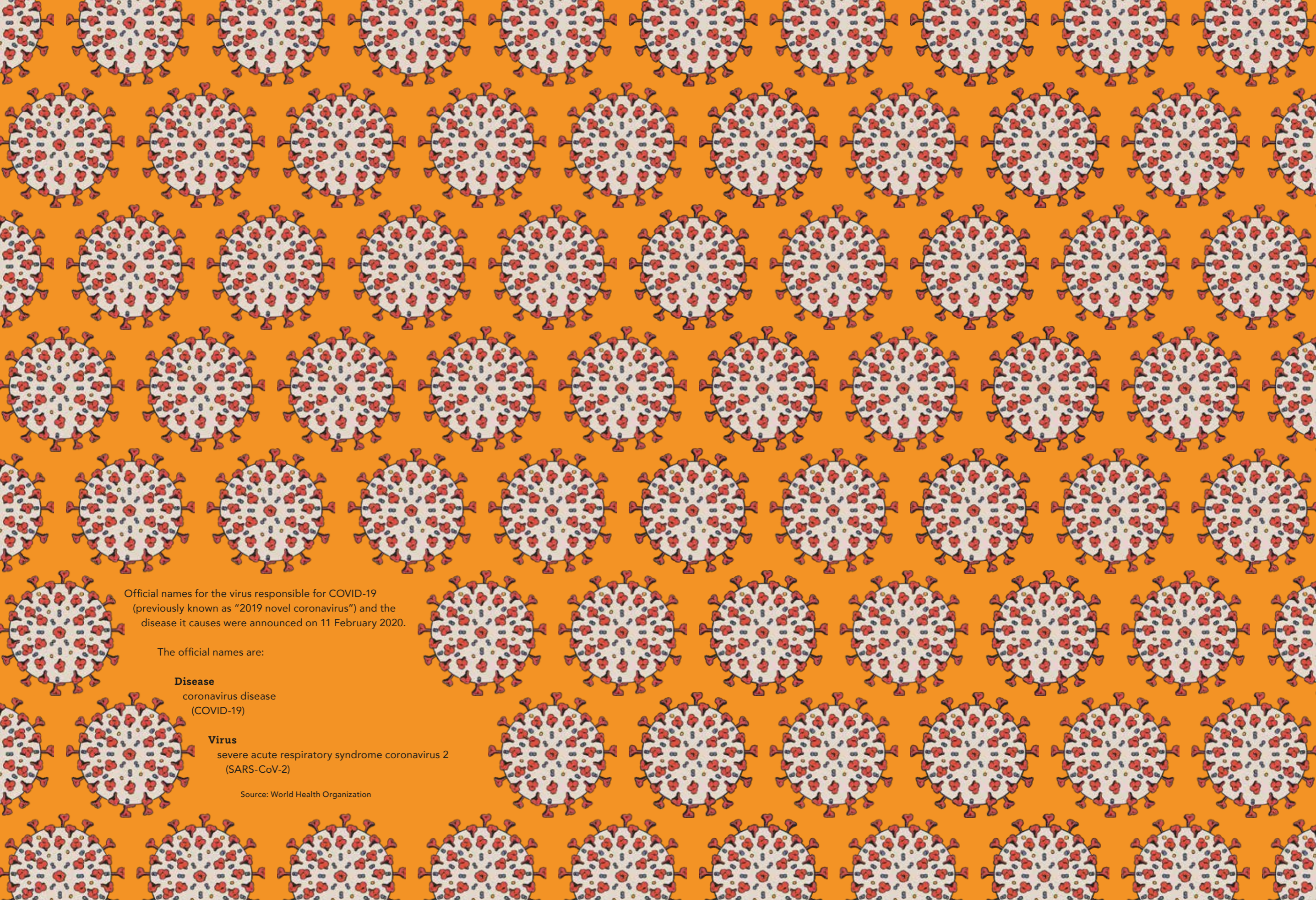


GOING VIRAL

AN ACADEMIC YEAR IN THE TIME OF COVID-19



YONG LOO LIN SCHOOL OF MEDICINE
YEARBOOK 2020



Official names for the virus responsible for COVID-19 (previously known as "2019 novel coronavirus") and the disease it causes were announced on 11 February 2020.

The official names are:

Disease
coronavirus disease
(COVID-19)

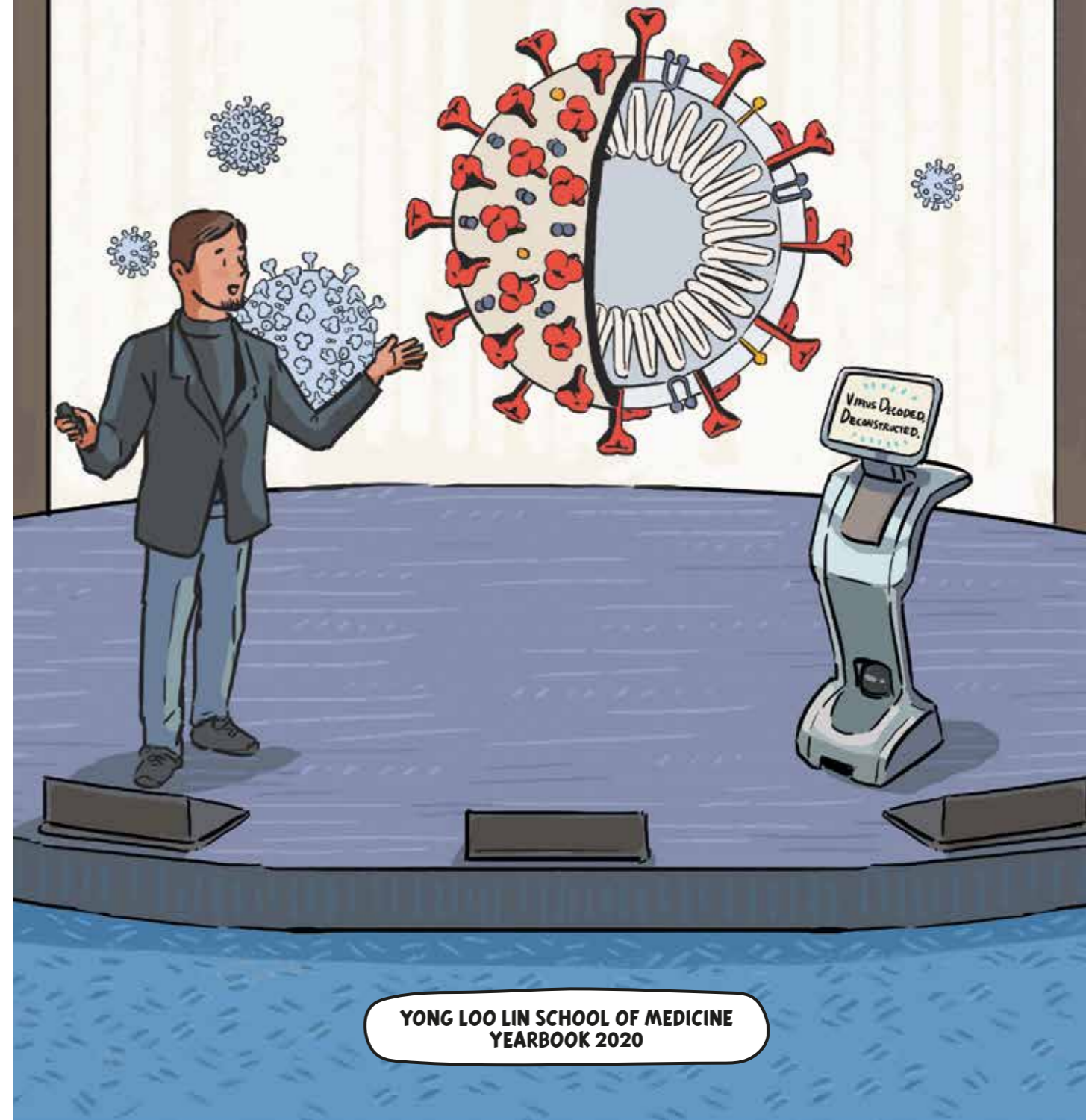
Virus
severe acute respiratory syndrome coronavirus 2
(SARS-CoV-2)

Source: World Health Organization

**GOING
VIRAL**

GOING VIRAL

AN ACADEMIC YEAR IN THE TIME OF COVID-19



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YONG LOO LIN SCHOOL OF MEDICINE
YEARBOOK 2020

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NO ONE IS SAFE



NO ONE WOULD have anticipated that the third decade of the 21st century would be defined by a virus. In just a year, a novel coronavirus infected 84 million people around the world, killing over 1.8 million. In the USA alone, 347,865 deaths have been attributed to COVID-19 as of 2 January 2021¹, more than US combatants killed in both World Wars. Harvard economists David Cutler and Larry Summers have estimated the pandemic to cost US\$16 trillion² over the next decade. One has to ask how this happened. But probably more importantly, the question that needs to be answered is: What have we learnt?

Pandemics are not novel. Neither are novel coronaviruses. Both have wreaked havoc among humans in the last century. Each time round, we have survived but we have not learnt nearly enough. SARS in 2003 taught Singapore major lessons but we still underestimated the dangers of this unfamiliar pathogen and succumbed to a massive outbreak among our migrant workers. After the initial missteps, Singapore learnt fast and responded well as a nation to arrive at the place we are now—low community infections, many restrictions relaxed, vaccinations initiated, and international travel being considered again. Unfortunately, the same cannot be said of many other countries at the moment. And that means that we are not, and cannot be, safe for now.

Learning to cope with COVID-19 is akin to a crash course in Life. The first lesson is that crises unfold in unexpected ways and we must be flexible and open to learning while remaining resilient—there is little place for unrelenting dogma in the face of the unknown. Values, yes. Dogma, no.

The second thing we learn is that crises unleash a torrent of misinformation as people grasp at straws and express their anxieties through ‘alternative facts’ that lend them a false semblance of control. This leads to the third realisation that critical inquiry is absolutely essential in crises. When little is known, science should remain the fundamental basis for rational decision making. The next lesson comes a little late but we now know

that not learning from the past jeopardises our future. History has shown repeatedly that humans, understandably and unfortunately, have short memories of unpleasant events, to their own cost.

The last two learning points are deeply social and, perhaps, difficult to grasp when times are good. Crises disproportionately affect the poor and vulnerable, exacerbating inequalities. It is easy for those who are more fortunate to be blind to this reality, but COVID-19 has shown us that we do so at our own peril—we need to embrace equity and moral purpose for our own, as well as everybody else’s, benefit. There is no escaping this fact. Along the same lines, a global and planetary mindset is necessary to maintain health, peace, and economic and ecological sustainability. This pandemic has exposed the ugly consequences of rapid globalisation coupled with ecological delinquency.

Have we learnt our lesson? In just over a month since Margaret Keenan, a 91-year-old grandmother in the UK received her first vaccine jab on 8 December 2020, nearly 19 million doses have been administered in 39 countries, according to data collected by Bloomberg³—mostly in the USA, China, UK, Russia, Europe, and the Middle East. Although 64 higher income countries have signed up with the COVAX Facility, a global initiative that brings together governments and manufacturers to ensure COVID-19 vaccines reach those in greatest need, many of these same countries have also been doing side deals to secure more vaccine doses for their own populations. National self-interest is a primal habit that is hard to break. But we need to do so if we are to move on and truly learn from this sad episode in history. The following stark warning has never held so true and become so important for us to remember as it does today: No one is safe until everyone is safe.

Chong Yap Seng
Lien Ying Chow Professor in Medicine
Dean, Yong Loo Lin School of Medicine
9 January 2021

References:

1. COVID-19 Dashboard by the Center for Systems Science and Engineering at Johns Hopkins University, accessed on January 2, 2021.

2. Cutler DM, Summers LH. The COVID-19 Pandemic and the \$16 Trillion Virus. *JAMA*. 2020;324(15):1495–1496.

3. <https://www.bloomberg.com/graphics/covid-vaccine-tracker-global-distribution/>, accessed on January 9, 2021.

CHAPTER 1
LOCKDOWN



LOCKDOWN

YEAR OF THE VIRUS

“The fight back against this pandemic is everyone’s business ... For governments, it means doing the same things we have been calling for since day one: know your epidemic. Break the chains of transmission. Test extensively. Isolate and care for cases. And trace and provide supported quarantine for all contacts. With these measures, you can catch up to this virus, you can get ahead of this virus, and you can stay ahead of this virus ...

And then, once you have the upper hand, it’s important to strengthen health systems, the health workforce, and contact tracing systems so that the virus doesn’t take hold again. Science continues to tell us the truth about this virus. How to contain it, suppress it, and stop it from returning, and how to save lives among those it reaches ... What will save lives is science, solutions, and solidarity.”



Dr Tedros Adhanom Ghebreyesus
Director-General, World Health Organization (WHO)
at the 26 October 2020 media briefing on COVID-19

With the lessons learnt from the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003, Singapore was able to care for COVID-19 patients and ensure a low mortality rate without overwhelming its healthcare system.

The NUS Yong Loo Lin School of Medicine joined in the national efforts to fight the COVID-19 pandemic while ensuring our patients, students, trainees, and staff stayed safe. Our contribution to pandemic preparedness included vaccine and antiviral therapeutic research, as well as the deployment of molecular diagnostic capabilities like the Biosafety Level-3 Laboratory to handle research on the SARS-CoV-2 virus.



Solutions and Support

Of top priority for the School during the year were healthcare solutions and support to strengthen Singapore's defence against the COVID-19 outbreak. NUS Medicine worked closely with other local institutions to develop research solutions and diagnostic support.

UNDERSTANDING T-CELL IMMUNITY TO COVID-19

PROF PAUL TAMBYAH and Assoc Prof Tan Yee Joo, with a research team from the Duke-NUS Medical School led by Prof Antonio Bertoletti, uncovered the presence of virus-specific T-cell immunity not only in people who had recovered from COVID-19 and SARS, but also in healthy study subjects who had never been infected by either virus.

T-cells, together with antibodies, are able to directly target and kill infected cells, making them an integral part of the human immune response against viral infections.

SARS-CoV-2 contains both structural and non-structural proteins (NSP). Of the structural proteins, the spike protein has been the most widely used in vaccine and antiviral drug development. In this first study, the team chose to study two of the NSPs and one structural protein known as the nucleocapsid protein (NP) to identify the SARS-CoV-2 proteins recognised by T-cells. NP is abundant in the virus and similar to the many viruses in the same class as SARS-CoV-2, such as the virus that causes the common cold.

The landmark study found that those who had recovered from mild or severe COVID-19 or SARS had T-cells that could

Paper reference:

Le Bert N, Tan AT, Kunasegaran K, et al. SARS-CoV-2-specific T cell immunity in cases of COVID-19 and SARS, and uninfected controls. *Nature*. 2020 Aug;584(7821):457-462.

Key findings on people who had COVID-19 or SARS

All 36 who had recovered from COVID-19 had T-cells that were specific for two regions of the SARS-CoV-2 NP, known as NP-1 and NP-2. Some of them also had T-cells specific to NSP7 or NSP13.

NP-1 and NP-2 were recognised by T-cells from the 23 people who had recovered from SARS in 2003.

NP-specific T-cells could multiply after being activated in cell culture with NP peptides.

Key findings on people who had not had COVID-19 or SARS

Around half of 37 people who had not been exposed to either SARS-CoV-1 or SARS-CoV-2 had T-cells specific for SARS-CoV-2 (both NP and NSP).

Their immune response was more likely to be dominated by T-cells that recognised NSP. This is in contrast to the NP-dominated T-cell response of COVID-19 or SARS-recovered individuals.

recognise SARS-CoV-2. In other words, those who had SARS still harboured the T-cells from their infection 17 years ago and these T-cells can recognise SARS-CoV-2. This suggests that previous SARS infections may facilitate the production of T-cells that help to protect against, or lessen, the effects of SARS-CoV-2 infection if SARS survivors become exposed to the SARS-CoV-2 virus.

A possible explanation for the research findings is that the people who had not been exposed to COVID-19 or SARS may have been exposed to common cold viruses and other related (possibly unknown) viruses. As a result, some of their T-cells remained after their infections had cleared, with the T-cells retaining their ability to recognise the SARS-CoV-2 virus.

“Understanding the human immune response to COVID-19 is crucial given the novel nature of this disease. Together with the other studies that have been done, our study gives us hope that there might indeed be long-lasting immunity to COVID-19, either from natural infection or a vaccine.”

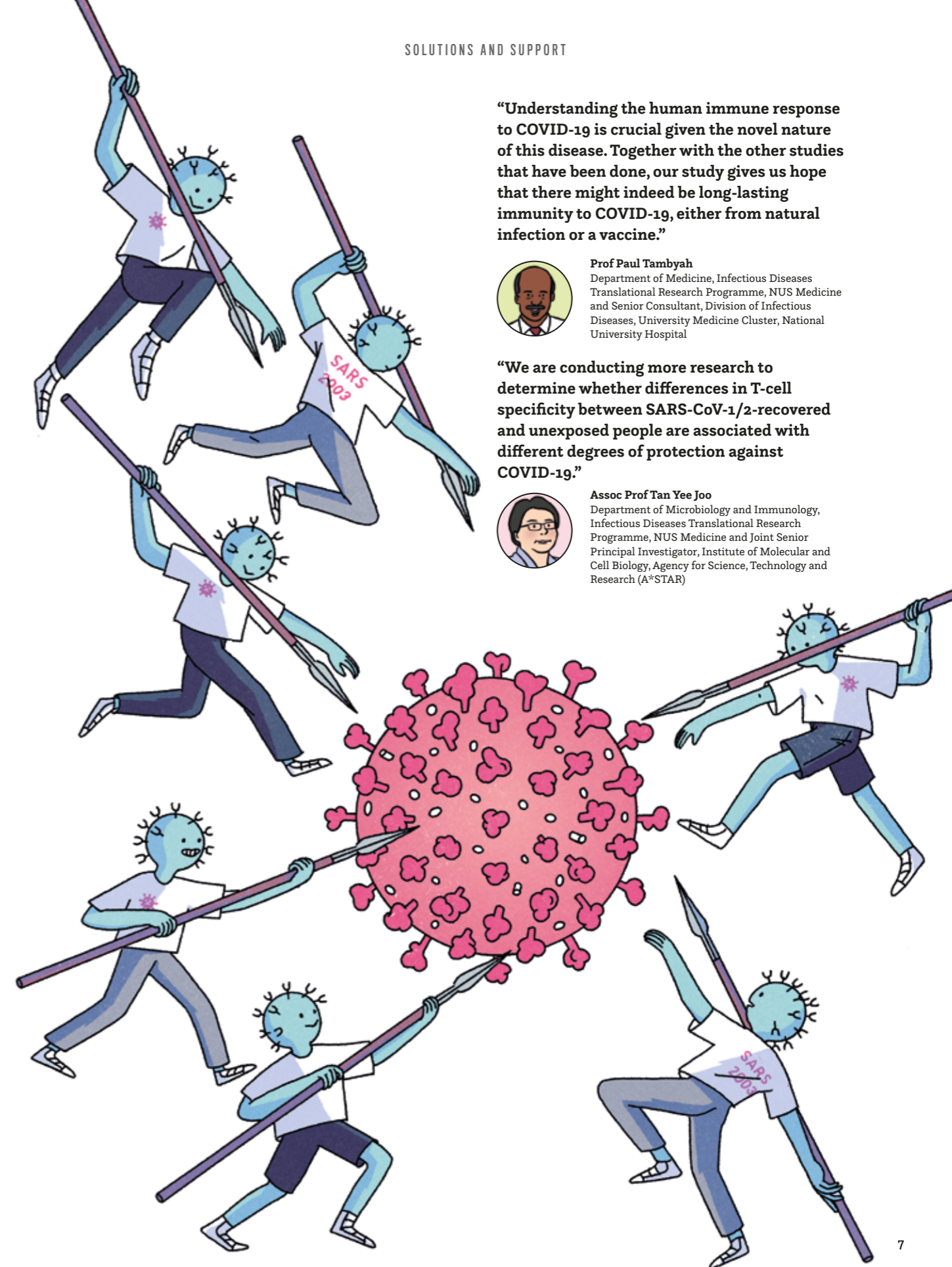


Prof Paul Tambyah
Department of Medicine, Infectious Diseases Translational Research Programme, NUS Medicine and Senior Consultant, Division of Infectious Diseases, University Medicine Cluster, National University Hospital

“We are conducting more research to determine whether differences in T-cell specificity between SARS-CoV-1/2-recovered and unexposed people are associated with different degrees of protection against COVID-19.”



Assoc Prof Tan Yee Joo
Department of Microbiology and Immunology, Infectious Diseases Translational Research Programme, NUS Medicine and Joint Senior Principal Investigator, Institute of Molecular and Cell Biology, Agency for Science, Technology and Research (A*STAR)



DIGITAL COVID-19 DRUG DEVELOPMENT – IDENTIF.AI PLATFORM

“To address emerging outbreaks, we need rapid and economical solutions such as IDentif.AI, which empowers digital drug development for COVID-19. Even as the world continues to race toward a vaccine, leveraging on AI can potentially open up a new pathway to accelerate the search for an accessible and optimised intervention that may help take the strain off healthcare systems.”



Prof Dean Ho
Provost's Chair Professor, Director, Institute for Digital Medicine (WisDM),
Director, The N.1 Institute for Health (N.1),
Head, Department of Biomedical Engineering, NUS

NUS MEDICINE'S INSTITUTE

for Digital Medicine, also known as WisDM, has been using artificial intelligence to power a dynamic new strategy that optimally designs drug combinations, and subsequently implements customised, single patient trials. This strategy is proving to be more effective than traditional, templated

clinical treatments. The clinical trials involved teams from diverse disciplines ranging from computing and engineering to public health and policy, healthcare economics and behavioural sciences.

WisDM pioneered a way to pinpoint effective drug mixes against COVID-19. The innovative strategy used is known as IDentif.AI (Optimising Infectious Disease Combination Therapy

with Artificial Intelligence), an interactive digital platform that can calculate the most effective combination of drugs and doses from a pool of 12 drugs under evaluation in multiple clinical trials.

IDentif.AI differs from conventional AI approaches, and does not rely on using pre-existing data to train algorithms and predict treatment regimens. Instead, it designs experiments using different permutations of drugs and doses to crowdsource the live virus to determine the combinations that optimise antiviral activity. At the heart of IDentif.AI is a powerful, AI-discovered relationship between drugs and doses, and efficacy and safety using a quadratic algebraic algorithm. This allows for the optimal combination to be identified from more than 530,000 possible combinations with only a few hundred experiments carried out within two weeks.

The smart platform is able to leverage unforeseen drug interactions within each combination, and then suggest optimised recommendations of

the drugs and corresponding doses. Results from the IDentif.AI platform have been observed independently by a team of international collaborators on another strain of SARS-CoV-2, and two study protocols have been cleared to enable clinical studies should they be required.

In addition to solutions for COVID-19, WisDM is developing digital therapies to mitigate cognitive decline in oncology patients and patients receiving brain radiation therapy. The Institute is also looking into therapies to address ageing and illness-related challenges.

Paper reference:

Blasiak A, Lim JJ, Seah SG, et al. IDentif.AI: Rapidly optimizing combination therapy design against severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) with digital drug development. *Bioengineering & Translational Medicine* 2020; e10196.

Ho D. Artificial intelligence in cancer therapy. *Science* 2020; 367(6481): 982-3.

Ho D. Addressing COVID-19 drug development with artificial intelligence. *Advanced Intelligent Systems* 2020; 2(5): 2000070.

Ho D, Quake SR, McCabe ER, et al. Enabling technologies for personalized and precision medicine. *Trends in Biotechnology* 2020; 38(5): 497-518.

Pantuck AJ, Lee DK, Kee T, et al. Modulating BET bromodomain inhibitor ZEN-3694 and enzalutamide combination dosing in a metastatic prostate cancer patient using CURATE. AI, an artificial intelligence platform. *Advanced Therapeutics* 2018; 1(6): 1800104.



Scan here to watch a video clip of the researcher discussing the project

THERAPEUTIC ANTIBODIES TO COMBAT COVID-19

“Our study involving months of intensive research used an innovative screening technique jointly developed by our research collaborators. By combining our complementary strengths in antibody biology, protein engineering, advanced informatics, and automated high throughput screening, we were able to identify the antibodies produced by human B-cells that can completely neutralise the SARS-CoV-2 wild type virus.”



Assoc Prof Paul MacAry
Department of Microbiology and Immunology, and Director,
Life Sciences Institute, NUS

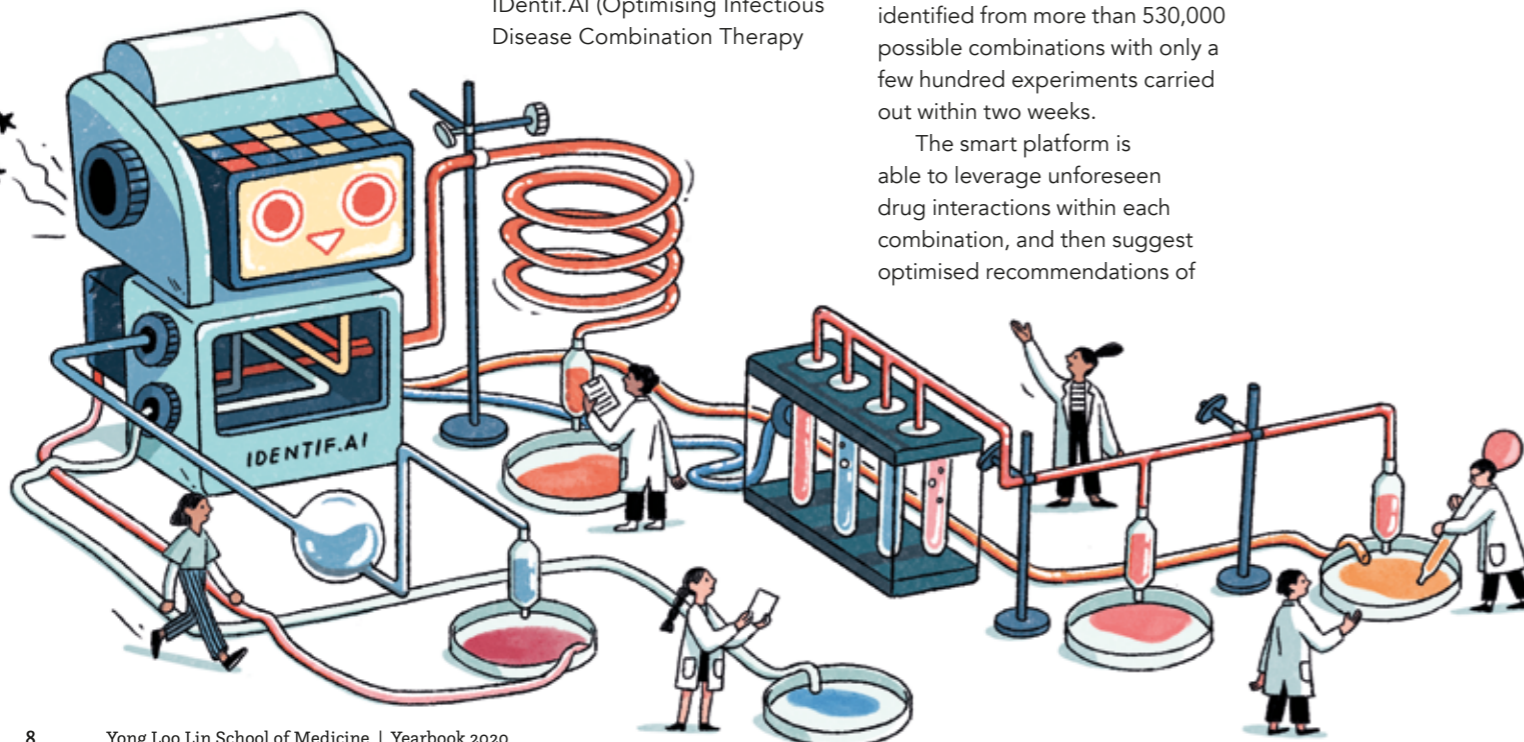
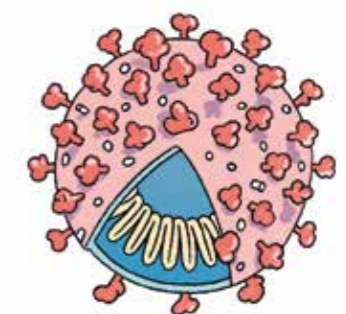
AS PART OF a whole-of-government collaborative effort, Assoc Prof Paul MacAry led a team to develop five new therapeutic or prophylactic antibodies with potent neutralising activity for the SARS-CoV-2 virus. Isolated from blood samples taken from recovered COVID-19 patients, the human monoclonal antibodies are therapeutic or prophylactic candidate medicines for the treatment of COVID-19.

The study found that the antibodies demonstrated better neutralising activity on the coronavirus than any other antibodies or small molecule drugs reported so far. The novel antibodies have been tested against live viruses and verified in the laboratory to negate their ability to infect and multiply in human cells. They have also been tested against different strains of the COVID-19 virus, and were found to retain full efficacy against key mutations.

A Singapore-based consortium comprising government agencies, research

institutes, and biomedical companies has advanced the research towards clinical trials. Human clinical trials for the lead antibody, AOD01, would be held after approval by Singapore's Health Sciences Authority. Manufacturing capabilities have also been provisioned to scale up therapeutic antibody treatment for COVID-19 patients upon the successful completion of clinical trials.

The antibody treatment shows promise beyond its use for the treatment of COVID-19 patients. It may be possible to use it as a form of passive vaccination while the development of active vaccines is still in progress.



NON-INVASIVE SENSOR

CARE MONITORING WITH prompt intervention is key to reducing mortality due to acute respiratory failure from COVID-19 pneumonia or acute pulmonary embolism. Studies have shown that 15% of patients with COVID-19 pneumonia can

deteriorate rapidly and require intensive care management. To allow remote monitoring, the research team focused on the development of respiratory sensors that provide continuous monitoring of a patient's respiratory and heart rates as

well as pulse oximetry. These vital parameters are transmitted in real time to a central station. The sensor by Respiree, a medical technology spin-off from Singapore's A*STAR, was developed in collaboration with the National University Hospital and NUS Medicine.

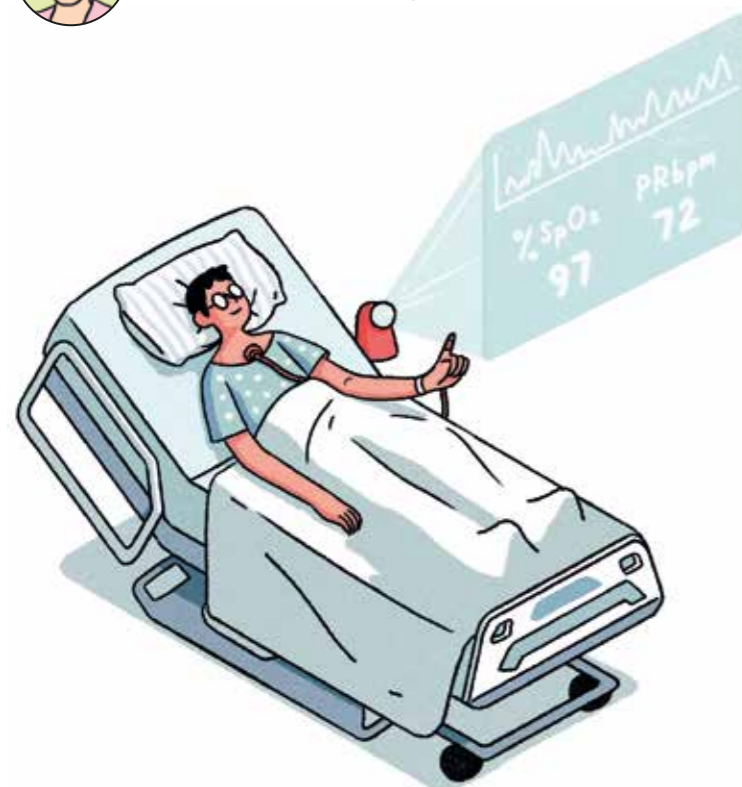
The sensor consists of two wearables, one attached to the chest and the other wrapped over a finger, to measure respiratory rate, breathing-pattern, and pulse oximetry indicative of oxygen content in the blood. These values are transmitted wirelessly to a unified dashboard in real time every five minutes, and the innovative technology uses built-in algorithms to identify patients at risk of clinical deterioration. Preliminary results of the study showed that prediction of clinical deterioration based on respiratory and cardiac parameters was possible up to 25 hours in advance.

The novelty of the research is in its use of respiratory biomarkers such as the depth of breathing, which is not a parameter that hospitals routinely measure.

“It is crucial and challenging to continuously monitor the conditions of isolated patients with COVID-19 pneumonia, in order to detect clinical deterioration for timely intervention. Hence, we focused our research on wearable technology to produce a non-invasive sensor that detects clinical deterioration ahead of time. These wearable sensors allow the relaying of a patient’s vital parameters to healthcare providers, thus minimising the risk of disease transmission.”



Assoc Prof Lee Pyng
Department of Medicine, Senior Consultant, Division of Respiratory & Critical Care Medicine, National University Hospital



Scan here to read the news article on the sensor

OVERCOMING SHORTAGES FOR TESTING

DURING THE PANDEMIC, healthcare institutions carrying out COVID-19 tests as part of public health surveillance measures needed support on several fronts. The School contributed a wide range of equipment and services such as essential supplies, consumables, and manpower. With the many disruptions to the global supply chain system caused by the COVID-19 outbreak, Singapore had to be innovative and self-sufficient in overcoming shortages for testing.

Nasopharyngeal swabs

Nasopharyngeal swabs are small, flexible sticks inserted through the nose to the back of the nasal cavity to collect fluid samples. They have specially designed tips to capture and retain samples in order for testing results to be accurate. With limited supplies of

nasopharyngeal swabs available for COVID-19 tests, Singapore had to find new ways of producing the swabs locally and ensuring a sustainable supply.

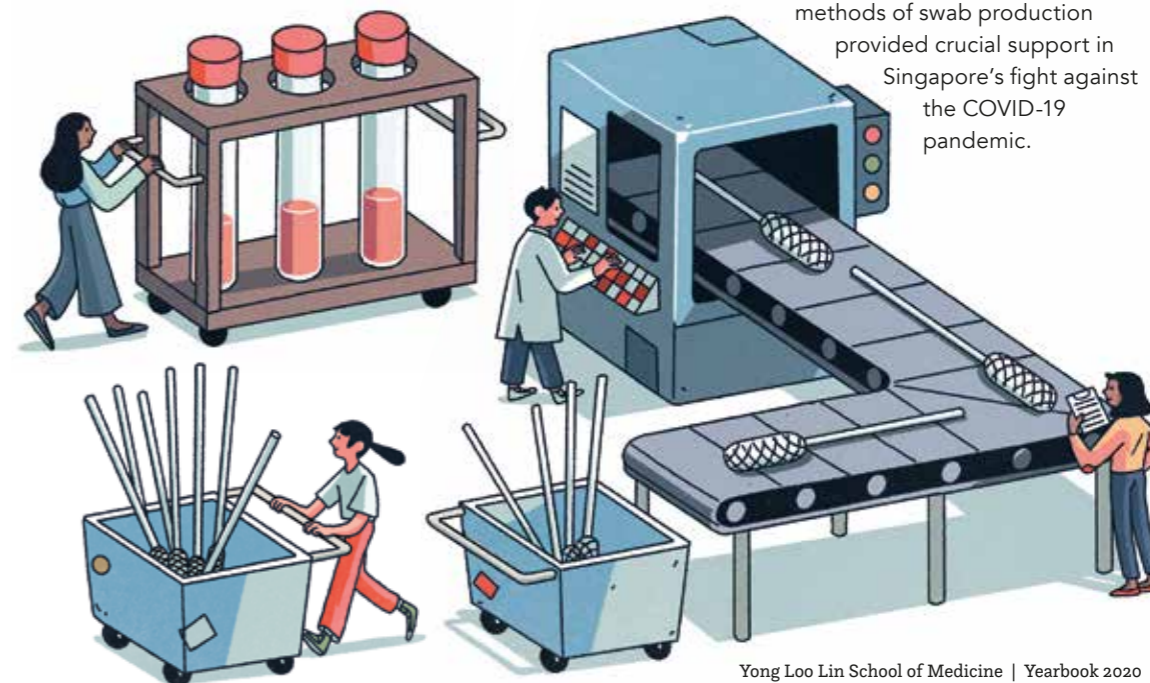
A multidisciplinary team of NUS researchers and NUHS clinicians, led by Prof John Eu-Li Wong, NUS Senior Vice President (Health Innovation and Translation); Assoc Prof David Allen, NUS Associate Vice President (Health Innovation and Translation); and Prof Freddy Boey, NUS Deputy President (Innovation and Enterprise), developed three different swab designs comparable to the industry-standard swabs. These swabs can be made using 3D printing and a manufacturing process known as injection moulding.

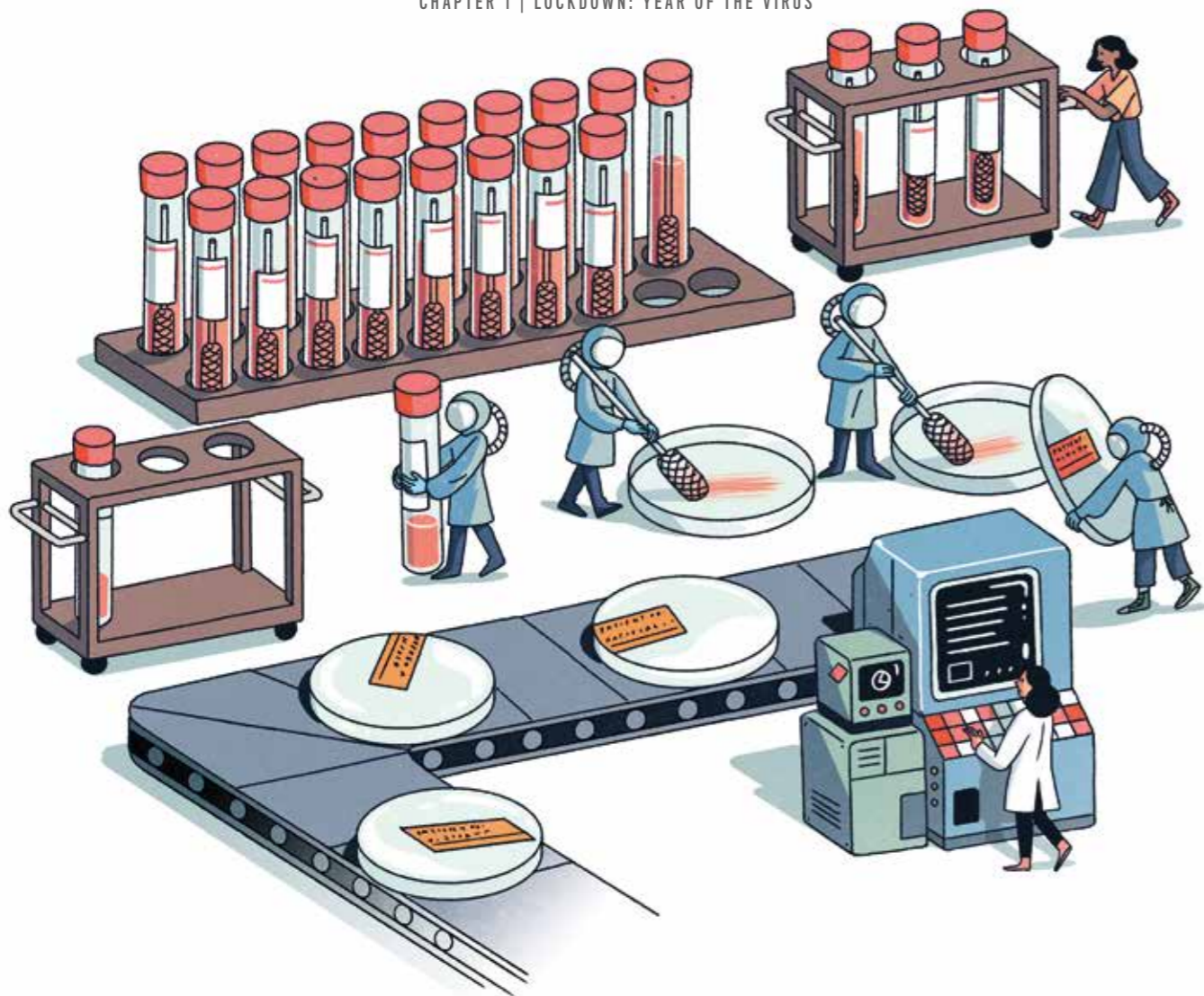
To first meet the pressing demand for test swabs, the team focused on using 3D-printing

technology as it was faster. The team successfully developed a patient-trialled, cost-effective, and manufacturable 3D-printed nasopharyngeal swab named Python. Having undergone pre-clinical testing and clinical validation, the non-flocked Python swab design has been in use at testing facilities.

Following which, the researchers developed an injection moulding process, a faster production method than 3D printing. The team's innovative swabs, known as IM2 and IM3, can be produced through injection moulding, which allows high volumes of swabs to be manufactured in a single cycle at low cost. This approach makes Singapore one of the first countries in the world to use injection moulding to produce swabs.

The NUS researchers' novel methods of swab production provided crucial support in Singapore's fight against the COVID-19 pandemic.





Equipment

Answering the call to meet shortages of testing equipment, the School pooled our resources to identify suitable hardware to loan to testing facilities. Equipment consisting of RNA extraction devices and real-time thermal cyclers that fit the test requirements were sourced from the different research facilities and generously contributed to the testing facilities. Our efforts allowed COVID-19 testing to continue without delay.

Manpower for clinical testing

As the COVID-19 situation worsened in Singapore in April 2020, the School responded to requests for support from healthcare institutions facing a shortage of manpower. These included the National University Hospital, Ng Teng Fong General Hospital, Alexandra Hospital, and Khoo Teck Puat Hospital.

The centres needed laboratory staff with molecular, clinical chemistry, and haematology skills to boost their testing efforts. In all, 39 NUS Medicine staff ranging from Research Fellows and lab

executives to faculty members and graduate students volunteered their time and skills to run tests on COVID-19 samples.

Most of the volunteers helped at the Laboratory Medicine labs in the hospitals, working 12-hour shifts in a period of four to eight weeks. The volunteers were given full training and all necessary vaccinations, and were kitted out in full personal protection equipment (PPE).



Scan here to watch a video clip of volunteers at work

Sharing Our Experiences

“The COVID-19 pandemic brought home to all of us the importance of global solidarity and how we must work together for global health. To me, the Hippocratic oath that we doctors pledge, ‘First, do no harm’, is no longer enough. We must ‘First, do good for humanity’, even if it is just to offer some comfort, encouragement, or help in some small way. Everybody matters. Every little bit helps.

As Singapore was one of the first countries to detect COVID-19 cases and implement control measures, we felt that we could share our learning experiences to benefit other countries at different stages of the COVID-19 outbreak. Given the novel nature of the virus and the unprecedented level of disease spread, we must all work together for recovery.”

Prof Chong Yap Seng, Dean, NUS Medicine

THE COVID-19 CHRONICLES

ONE OF THE first initiatives that NUS Medicine undertook was to contribute to clear communication to the public on the coronavirus and the public health measures to adopt.

Thus were the COVID-19 Chronicles created. Framed as an "Ask an Expert" series of illustrations, it featured Prof Dale Fisher, Professor in Infectious Diseases, NUS, and Chair of the WHO Global Outbreak Alert and Response Network (GOARN).

The first illustrated strip was published on the NUS Medicine website and social media

platforms on 14 February 2020, with the 100th strip published on 6 October 2020.¹ The Chronicles aimed to give the public accurate and timely advice to help them understand the disease and adopt precautionary health measures. The series also sent messages of encouragement to the healthcare workers and researchers battling the pandemic, as well as supportive ones to the general reader to promote mental health.

The light-hearted approach taken by the Chronicles for important health messaging

drew favourable public attention. The illustrations were translated and shared by global media, and where suitable, adopted by the WHO's Global Outbreak Alert and Response Network states.

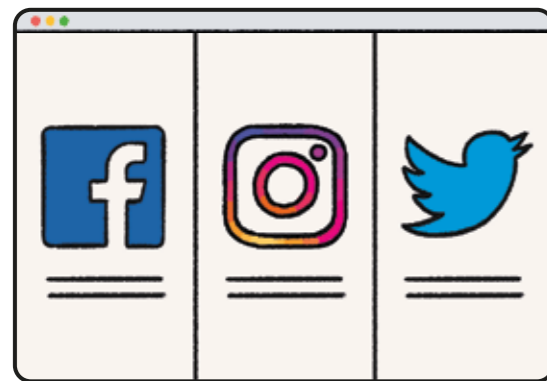
The following pages show a few of our top performing comic strips.

¹ The comic strips resumed on 14 Dec 2020.



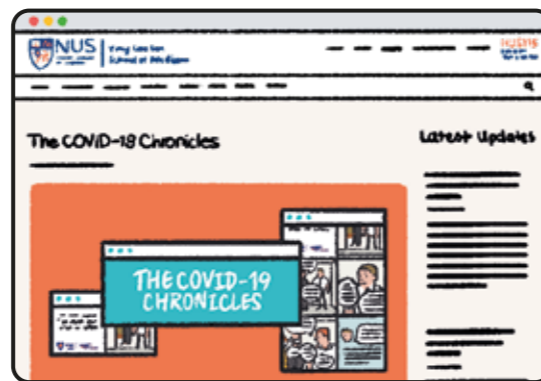
Scan here to watch the video on the comic strips

Total reach on social media:



4,000,470

Total website page visits:



52,188

*As of 26 Jan 2021

Comic strip #2

Posted 15 Feb 2020

Total reach on social media: 560,611

*As of 26 Jan 2021



Comic strip #5

Posted 18 Feb 2020
 Total reach on social media: 54,200
 *As of 26 Jan 2021



Comic strip #13

Posted 29 Feb 2020
 Total reach on social media: 44,692
 *As of 26 Jan 2021



Comic strip #14

Posted 3 Mar 2020
 Total reach on social media: 327,717
 *As of 26 Jan 2021



Comic strip #101

The series resumed on 14 Dec 2020.
 Total reach on social media: 11,262
 *As of 26 Jan 2021



Comic strip #106

Posted 31 Dec 2020
 Total reach on social media: 9,598
 *As of 26 Jan 2021



ENGAGING WITH A GLOBAL AUDIENCE

OTHER PLATFORMS THAT
 NUS Medicine adopted to ensure a wider outreach included the harnessing of technology to share clinical and research findings through webinar series.

“COVID-19: Updates from Singapore” webinar series
 The first of 24 webinars was launched on 9 April 2020 as a weekly forum for clinicians, scientists, public health officials, and policymakers with expertise in COVID-19 to share insights from their fields of study.

The episodes included updates on world and regional COVID-19-related epidemiology, a detailed COVID-19 topic review by a different guest lecturer each week, followed by a panel discussion and questions from the audience. The platform also served as a Continuing Education and Training webinar for healthcare professionals.

The series was well-received, with participation by more than 70,000 participants from more than 70 countries. The last session, held on 17 September


















2020, featured 16 speakers, including WHO Director-General Dr Tedros Adhanom Ghebreyesus.

Subsequent to these weekly sessions, monthly updates following the development of COVID-19 continued from December 2020.



Scan here to view the YouTube channel

GUEST SPEAKERS FROM THE FINAL EPISODE OF THE “COVID-19: UPDATES FROM SINGAPORE” WEBINAR SERIES

- | | | | | | |
|---|--|---|---|---|---|
|  | Prof Chong Yap Seng
Dean, NUS Yong Loo Lin School of Medicine |  | Prof David Nabarro
Co-Director and Chair of Global Health, Institute of Global Health, Imperial College London |  | Dr Tedros Ghebreyesus
Director-General, World Health Organization |
|  | Prof John Eu-Li Wong
Isabel Chan Professor in Medical Sciences, Senior Advisor, National University Health System, Singapore |  | Prof Trish Perl
Chief, Division of Infectious Diseases and Geographic Medicine, The University of Texas Southwestern Medical Center |  | Prof David Heymann
Professor of Infectious Disease Epidemiology, London School of Hygiene and Tropical Medicine |
|  | Dr Ali S. Khan
Dean, College of Public Health Professor, Department of Epidemiology, University of Nebraska Medical Center |  | Assoc Prof Kenneth Mak
Director of Medical Services, Singapore Ministry of Health |  | Dr Howard Njoo
Deputy Chief Public Health Office, Public Health Agency of Canada |
|  | Dr Larry Madoff
ProMED Editor, International Society for Infectious Diseases (ISID) |  | Dr Chikwe Ihekweazu
Director General Nigeria Centre for Disease Control (NCDC) |  | Dr Margaret (Peggy) Hamburg
Former Commissioner of the US Food and Drug Administration (FDA) and NYC Department of Health |
|  | Prof Richard Horton
Editor-in-Chief and Publisher of <i>The Lancet</i> , UK |  | Dr Marie-Paule Kieny
Director, Inserm, France |  | Dr Sharon Salmon
Technical Officer, GOARN, WHO – Western Pacific Region (WPRO) |
| | |  | |  | Patrick Drury
Project Manager, GOARN, WHO |

SPEAKERS FROM THE “COVID-19: UPDATES FROM SINGAPORE” WEBINAR SERIES



Assoc Prof David Allen
Associate Vice President,
Health Innovation and
Translation, NUS



Prof Dale Fisher
Professor of Medicine, NUS
Medicine, Group Chief of
Medicine, National University
Health System (NUHS), Chair
of GOARN, WHO



Dr Louisa Sun
Associate Consultant,
Infectious Diseases,
National University
Hospital and Alexandra
Hospital

SPEAKERS FROM “COVID-19: BIOMEDICAL INSIGHTS INTO AN EVOLVING EPIDEMIC” WEBINAR SERIES



Assoc Prof Juan Pablo Bifani
Department of Microbiology
and Immunology, NUS
Medicine



Assoc Prof Kevin Tan
Head, Department
of Microbiology and
Immunology, NUS
Medicine, Vice-Dean
(Graduate Studies),
NUS Medicine

“COVID-19: Biomedical Insights into an Evolving Epidemic” webinar series

The ‘COVID-19: Biomedical Insights into an Evolving Epidemic’ series of eight webinars provided an in-depth look at the biology and biomedical research behind the COVID-19 pandemic. Held in July 2020, each episode featured discussions ranging

from the epidemiology of the outbreak and prediction models to immunology, therapies, and vaccine development. This educational series of webinars was targeted at relevant scientists.



Scan here to read a reflective article written by the organisers

Sharing measures for academic continuity

NUS Medicine also shared with the wider community the multi-faceted teaching and assessment approach the School took during the COVID-19 outbreak to ensure academic continuity.

Information on the measures to protect our students, staff, and patients while continuing the training of students and residents was published online in May 2020. The aim of the publication was to provide a useful reference for other schools evaluating their pandemic preparedness in their own countries during the COVID-19 pandemic or for similar crisis events in the future.



Scan here to read the journal article

Service in the Midst of Crisis

This pandemic has united the School in the fight against COVID-19. Just as crucially, it has brought us closer to the people we have pledged to serve.

We have seen conventional practices upended, but proven our resourcefulness in reacting quickly and effectively, not only within our own domain but also in reaching out to the community, especially the hardest-hit migrant worker community.

Vice-Dean for Education, Assoc Prof Lau Tang Ching, remarks on changes in the staff and students during this period: Resilience and the readiness to embrace change, along with new-found competencies. Strong trust-based relationships, which have enabled the School’s values of Respect, Integrity, Compassion, and Humility.

Service in the midst of a crisis has brought out the best in us. As Assoc Prof Lau says, “The School’s vision is being realised. We continue to Inspire Health for All.”

WHAT BINDS US

“MIND-BOGGLING” IS how Assoc Prof Zubair Amin describes the scale of medical support operations at Singapore’s largest migrant worker dormitory during the COVID-19 outbreak.

Hosting one of the biggest clusters of cases, the Sungei Tengah Lodge had seen its vulnerable tenants shut in to contain the spread. The Ministry of Health deployed teams of doctors, nurses, paramedics, pharmacists, and other operations personnel to take care of the 25,000 residents there, and Assoc Prof Zubair was not slow to volunteer.

Putting in up to seven hours a day every weekend, on top of his teaching commitments and full-time work at the National University Hospital, the neonatal specialist found himself having to orientate to a very different environment. He admits to taking a while to overcome the apprehension of walking into what seemed to be the centre of the pandemic. And there was, too, the physical challenge of working in full PPE in the non-air-conditioned medical posts, and being constantly on his feet.

On top of things, the period coincided with Ramadan. Assoc Prof Zubair, who is Muslim, prepared notes for his co-volunteers, suggesting how doctors and nurses could adjust prescriptions and advice for patients observing the Islamic fasting month.

All things considered, Assoc

Prof Zubair deems the time spent rewarding.

“This was a serious responsibility, but also a unique opportunity to connect with a group of people who are usually underserved,” he says.

Indeed, connecting turned out to be a challenge in itself. The sheer numbers being seen at the medical posts meant an intense schedule, with him and his fellow colleagues at the medical post tending to up to 100 patients each shift. The five to ten minutes he spent with each patient barely allowed him to attend to their concerns, let alone build a relationship.

However, Assoc Prof Zubair had an advantage—he speaks Bengali. Many of the migrant workers hail from Bangladesh, and one told the doctor, “I feel better already just talking to you.” It was just one instance in which the doctor was struck by the gratitude the workers showed for the volunteers’ support. They had been fearful, but were comforted seeing

help at their doorstep. It taught Assoc Prof Zubair that in such circumstances, a few words of reassurance, especially given in a native tongue, can prove more important than anything else. In this way, the medical teams were able to quickly develop faith with the patients.

Among the volunteers, the rapport was equally palpable. Assoc Prof Zubair describes how trust was built and volunteers bonded quickly, even if they could not actually see each other under their PPE. Just knowing they were working for the same purpose—that was all they needed, and it sent a strong message: Together we can overcome.



Assoc Prof Zubair Amin
Department of Paediatrics



Scan here to hear more from Assoc Prof Zubair



OVERNIGHT SUCCESS



THE NIGHT IT was announced that foreign worker dormitories were housing record numbers of COVID-19 cases, Dr Sudesna Roy Chowdhury experienced “a burst of emotion”. The figures, she knew, would only escalate.

Even as medical teams were readying for deployment at all 43 dormitories around the island, the alumna from the Class of 2020 felt compelled to help. She had been volunteering as a Bengali interpreter for doctors that week, and her first thought was that there needed to be a faster, easier way for the frontliners to communicate with patients.

Some 200,000 workers reside in these dormitories, most of whom speak little English. With such a large group needing to be checked, there would be little time to waste on inefficient communication.

Dr Roy Chowdhury decided on a twofold objective: for frontliners to be able to conduct a first consultation without needing an interpreter, and for

doctors to have direct access to an interpreter when they needed one. “I wouldn’t wish for any doctor to say that patient care was compromised because of a communication barrier,” she shares.

Despite having no experience and it being in the middle of the night, the sleepless 24-year-old started to create a translation website. With help from her sister, an emergency doctor, and her Bengali-speaking parents, Dr Roy Chowdhury compiled and translated a list of phrases doctors might use for checking the symptoms, medical history, and past interactions of patients. The audio versions were then recorded in the still of the night. A contact list of 13 volunteer translators was uploaded; instructions for patients on monitoring their health and maintaining personal hygiene were added.

Incredibly, her English-to-Bengali portal was launched just eight hours later, ready when the new batch of doctors entered the

dormitories. Dr Roy Chowdhury sent her translation tool to a handful of doctors; within the hour, it had been shared with thousands more, from those in hospitals to those in the Army Medical Services who were on-site at the dorms.

“Thank you,” said many texts received. Doctors related how they had been using broken English and gestures to converse with the migrant workers, having no time to look for interpreters. Her easy-to-use tool, they tell her, “is a staple now”.

The popular portal attracted supporters who helped develop the website further. It has since been beefed up with document translations, facts about the virus, and mental health resources. The volunteer pool has expanded to over 100 Bengali-speaking interpreters who help with translation work, food distribution, and mental health support. Still others have been inspired to build translation websites in Tamil, Hindi, Telugu, Sinhalese, Malayalam, Malay, Mandarin, and Thai.

Everyone wants to pitch in, Dr Roy Chowdhury notes, saying, “This makes me very hopeful for humanity.”



Dr Sudesna Roy Chowdhury
MBBS Class of 2020,
NUS Medicine



Scan here to visit the translation website

KEEPING DREAMS ALIVE

IN THE MIDST of the pandemic, educator Dr Tam Wai Jia pondered her role. The Deputy Lead of Global Health and Community Service at NUS Medicine, her alma mater, was “preaching about rekindling humanity in medicine and overcoming adversity”, but from well within her comfort zone.

It had been seven years since she had last donned scrubs. When her mentor, Assoc Prof Malcolm Mahadevan, who was active on the frontline, asked if she was willing to return to clinical work, she thought of the risks to her husband, a liver transplant survivor who was immunocompromised, and her infant. Yet, going straight into the migrant worker dormitories where the outbreak was concentrated in the early months of the pandemic, both she and her husband knew it was the right decision.

Assoc Prof Mahadevan soon approached Dr Tam to create a health booklet for the community isolation facility residents. Dr Tam, founder of award-winning non-profit organisation Kitesong Global and author of four inspirational picture books, was unsure if her gifts in illustration and communication would be of worth. Still, she worked late nights and galvanised volunteers from Kitesong Global and her medical students to help. She was propelled by Assoc Prof Mahadevan’s deeply inspiring mentorship and example, as well as her husband’s words,

“Whatever your hand finds to do, do it with all your heart.”

In a pandemic, risk communication and community engagement are critical enablers of outbreak control, but are often last to be implemented. The booklet filled this gap, engaging the migrant worker community, allaying their fears, and winning their trust during the crisis. The resource offered words of reassurance and hope, encouraging workers to hold on to their dreams.

When Prof Dale Fisher, Professor in Infectious Diseases, NUS, and Chair of the WHO’s GOARN, chanced upon the booklet, he requested to meet Dr Tam, and a new initiative began. From one health booklet, the project grew to encompass a series of booklets, posters, and later, a digital campaign that would reach tens of thousands.

A mere handful of volunteers soon burgeoned into more than 160 volunteers from Singapore and beyond, who translated the multimodal resources into eight languages and put them up on a centralised website. Migrant worker leaders themselves contributed to these efforts, even as they developed real connections and friendships with the doctors.

A facilitated art therapy workshop curated by Dr Tam for migrant workers under quarantine opened conversations about disruption and resilience, disappointment and hope. “How poignant,” Dr Tam shares,

referring to a session when migrant workers drew their dreams on kites, “that these kites, powerful images of freedom, were made with kite-tails of barricade tape, symbolic of quarantine and confinement.” The messages penned touched the volunteers, too. One worker hoped his daughter would become a doctor, “because all the doctors here in Singapore help us so much”.

The initiative moved on to social media, where through artwork, poetry, and song, the migrant workers shared their experiences. A series of Facebook Live sessions titled “Keep Hope Alive!”, led by medical students and co-hosted by migrant worker leaders from the Bangladeshi community, received 15,000 views at its launch and more than 42,000 views in subsequent episodes with guest speakers.

By June, this snowballed into “My Brother SG”, created in partnership with Kitesong Global, migrant worker NGO Healthserve, and Singapore’s three regional health systems. Medical and other faculty students across NUS stepped up to volunteer. Doctors who spoke Bengali, Tamil, and other languages poured themselves into the project, on

top of their day jobs. Dr Tam is encouraged by both the flood of selfless support from the team as well as the immense courage and resilience of the migrant brothers. She quotes Prof Dale Fisher: “The best thing about an outbreak is the amazing people you meet’.”

The story does not end here. At the end of 2020, Dr Tam received increased support from NUS and a grant from the WHO to further help migrant workers.

Dr Tam will also be collaborating with experts from the WHO, UNICEF, and the International Federation of the Red Cross, and sharing about the work in Singapore.



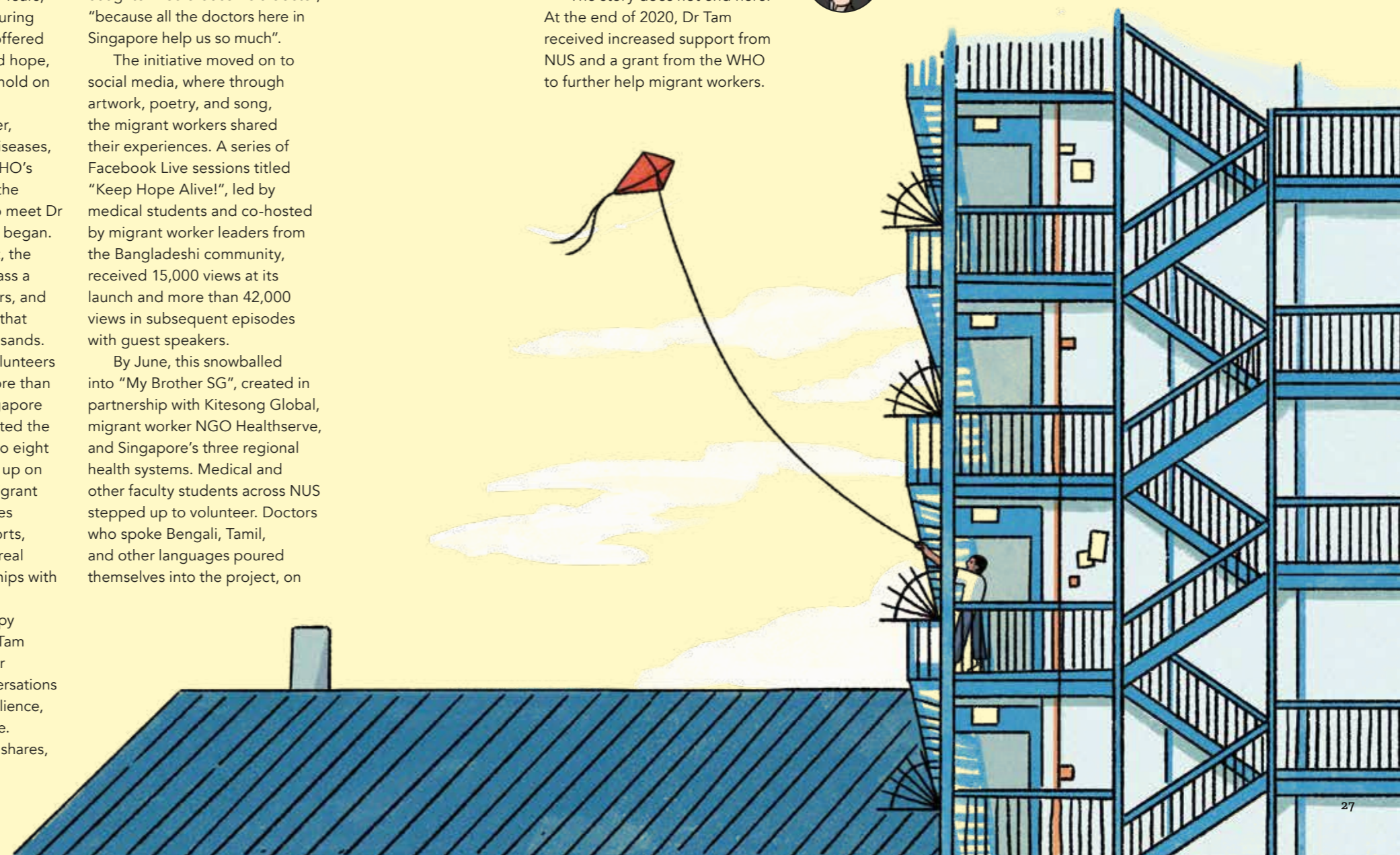
Dr Tam Wai Jia
Deputy Lead, Global Health & Community Service



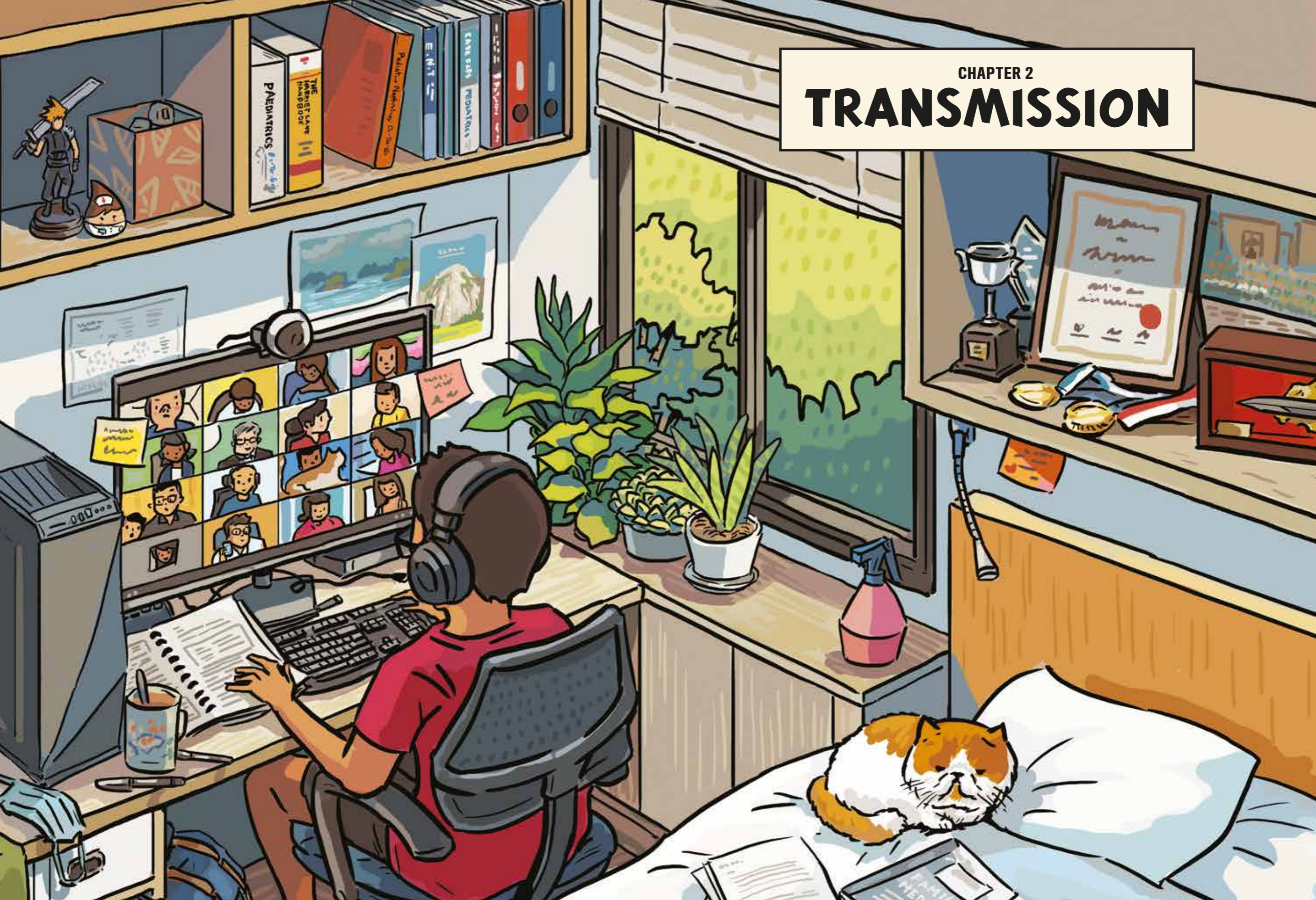
Scan here to watch the WHO video



Scan here to go to My Brother SG’s Facebook page



CHAPTER 2
TRANSMISSION



NOTHING SPREADS LIKE KNOWLEDGE

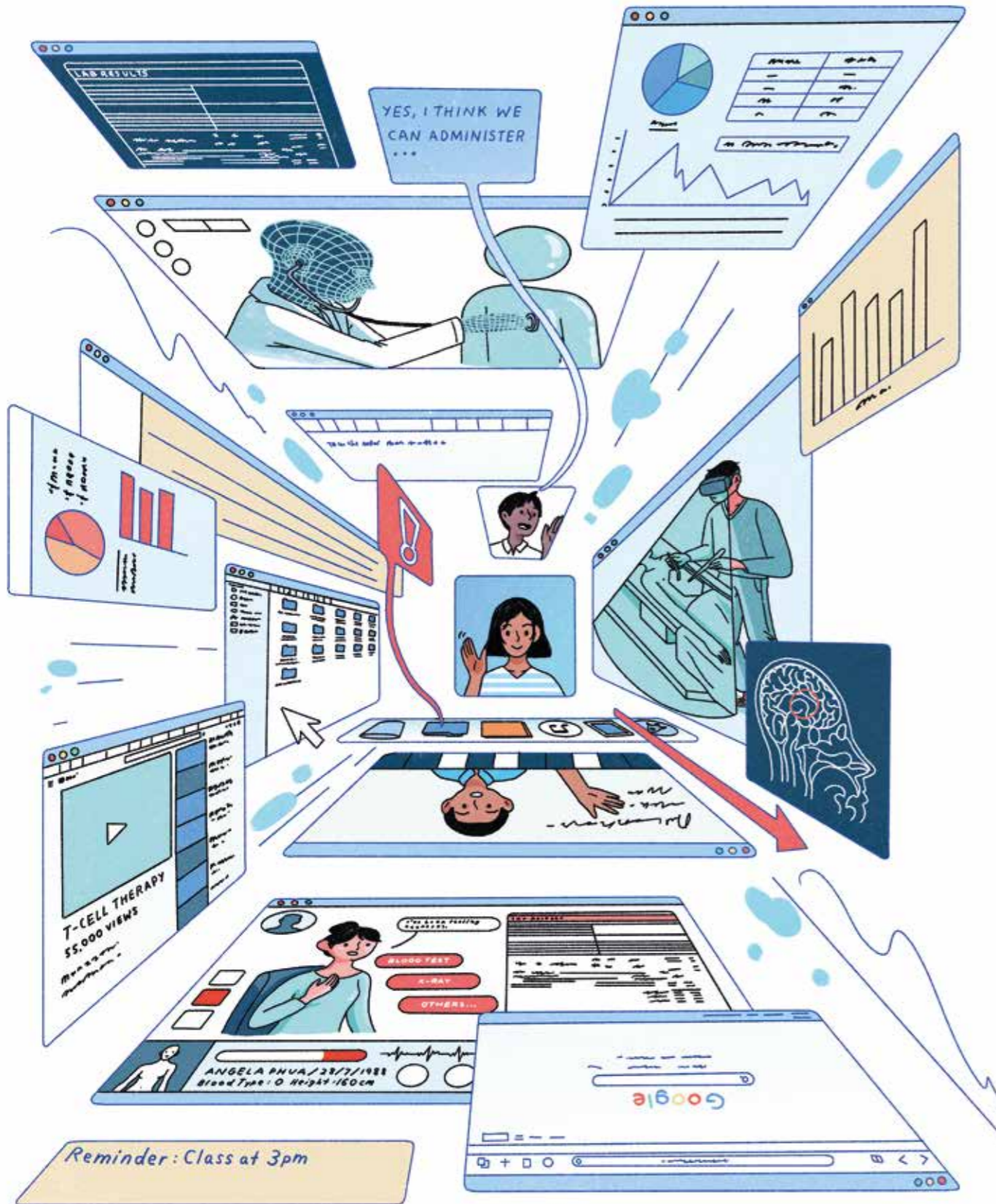
“The COVID-19 pandemic has changed education in two ways: firstly, our school’s vision, Inspiring Health for All, has become more relevant and important than ever; secondly, the fact that no one specialisation or profession can solve the complex health problems we face today is now irrefutable.”



Assoc Prof Lau Tang Ching
Vice-Dean (Education), Yong Loo Lin School of Medicine

Learning and assessment are necessary in healthcare institutions—they are not just found in books and the lecture theatre—and interactive technology injects a shot of inspiration to the learning experience. In this, NUS Medicine aims to be a leader, developing innovative models of teaching, learning, and assessment. At the same time, we see a way forward enhancing cross-discipline and lifelong learning, and the chance to nurture the diverse talents of every student, staff, and administrator.

As Assoc Prof Lau says, it all goes back to the School’s vision of Inspiring Health for All. A vision, he believes, that is entirely achievable.



Turning to Technology for Training

This is a tech-savvy generation that we are instructing. Students count on a quality education at NUS Medicine, but can they expect one taught in their native digital language?

Absolutely. The School's early investment in technology has unlocked new planes of learning in virtual and mixed reality, with simulation tools and gamification supplementing and filling the gaps in current teaching methods.

Our efforts began early in 2015 with small-scale experimentation with digital tools. Grant support was forthcoming and by 2019, the School's digital transformation strategy was formalised.

Today, the Medical Education, Technology and Enterprise (METE) committee set up by the Vice-Dean of Education, Assoc Prof Lau Tang Ching, provides the resources, networks, and support for those interested in advancing technology.

It offers a conducive environment which nurtures new projects, helps find the curriculum space to implement them, and assists in translating them into enterprises or making them available to other schools to use.

The main benefits from employing these digital tools have been unambiguous: engaged students and improved learning; better care for patients; and cost-effective training.

PASS-IT—PATIENT SAFETY IN SURGERY AS INTER-PROFESSIONAL TRAINING

THE DOORS TO surgical operating theatres may have been barred to students because of the pandemic, yet access to a fully immersive learning experience behind them was not denied.

Assoc Prof Alfred Kow, Assistant Dean of Education, piloted a new module in patient safety at the start of Phase II of Singapore’s reopening, while students were still being kept out of the high-risk operating arena. His virtual reality (VR) digital gaming system, in joint development since 2018 by the surgery, anaesthesia, and dentistry disciplines, certainly could not have launched at a better time.

Patient Safety in Surgery as Inter-Professional Training, or PASS-IT, as the project is

called, was crafted against a backdrop of growing complexity in the healthcare system, where communication gaps can compromise patient safety. As critical as the topic is, it is challenging to teach in proper context, Assoc Prof Kow notes. Lectures and tutorials may well be the least productive way.

Instead, students don VR headsets and take up hand-held controllers to enter a virtual operating theatre, collaborating with healthcare professionals from other disciplines through their avatars to manage a Hepatitis C cirrhotic patient. Working in real-time, they go through the whole flow of preoperative, intraoperative, and postoperative stages of

surgery. From dental clearance to anaesthesia evaluation and the handling of sharps, students gain a macro perspective of each role within the operating theatre. It is a chance to see and understand what often passes as “other people’s duties”.

PASS-IT won over the students who were involved in the pilot—56 fourth-year medical students in their anaesthesia postings and 36 third-year medical students who had just completed their clinical rotations in surgery. The interactive gaming aspect allows them to make mistakes, learn patient safety, and practise inter-professional communication in a safe space, ensuring their competency before they enter real clinical environments to care for actual patients.

The situational patient scenario in PASS-IT also allows for universal training of all students in a uniform manner, removing the opportunistic fashion of clinical training to some extent.

PASS-IT is due to be rolled out as a compulsory module, and may reach others training in the health professions, including nursing and dental students.



Scan here to watch the video clip



Assoc Prof Alfred Kow
Assistant Dean (Education),
NUS Medicine

THE VIP

BONING UP ON communication and diagnostic skills at a time when face-to-face interactions are put on pause? Not a problem when your subject is a VIP, or Virtual Integrated Patient.

VIP uses a random patient generator to expose students to various clinical cases. Remarkable for its conversational technology, this easy-to-navigate interface is designed as a doctor consultation over a messaging app. Realistic case information based on real-life data enables students to hone their competency in history-taking and diagnosis. The multidimensional portal, which also allows students to perform physical examinations and run realistic laboratory investigations, has proven to be an invaluable adjunct to medical teaching.

As an artificial intelligence response to restricted clinical sessions, the virtual hospital setting of VIP was welcome additional practice for second-year students who took part in the pilot programme. Its launch during the transition to online classes due to the COVID-19 pandemic meant learning was not disrupted but rather, more flexible.

The VIP team, led by Prof Edmund Lee and Dr Judy Sng from the Department of Pharmacology, likens their project to flight simulator training for pilots. Students gain in confidence as they train on the system anytime and anywhere. VIP focuses on the process of reaching a conclusion, rather than the actual diagnosis, and

the diversity of clinical cases has also given rise to more active discussions within tutorial groups, to the students’ benefit.

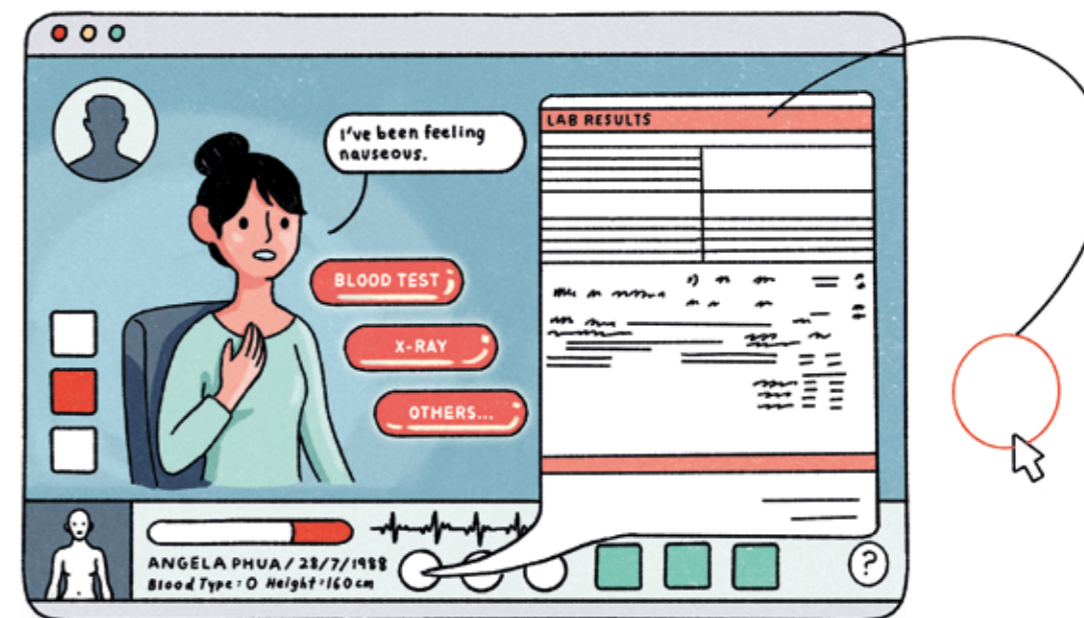
VIP continues to advance. Year 4 students on the Education Innovation Pathway have developed the platform further, with more modules being created and implemented. Another barrier to learning, even home-based learning, has been overcome.



Prof Edmund Lee
Department of
Pharmacology



Dr Judy Sng
Senior Lecturer,
Department of
Pharmacology



GETTING CREATIVE

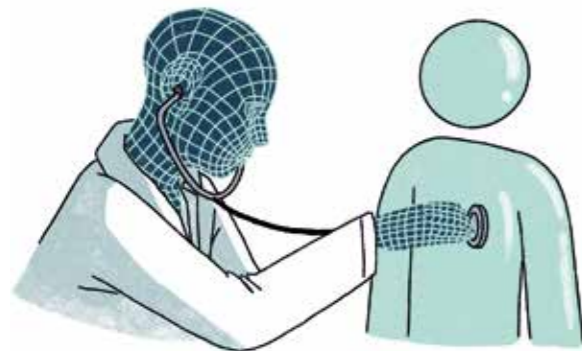
WHEN COLLABORATIVE OPPORTUNITIES

were stepped down during the pandemic, inter-professional project CREATIVE stepped in—and medical and nursing students stepped up to practise doctor-nurse communication in a 3D virtual world, as groups of pretty realistic avatars.

Conducting bedside rounds in a simulated hospital, teams of six final-year students from three of Singapore's institutions of higher learning—National University of Singapore, Nanyang Polytechnic, and Singapore Institute of Technology—learnt to work together, in research trials that have seen positive results. They hailed from medical, nursing, physiotherapy, occupational therapy, pharmacy, and social work disciplines, role-playing in patient care scenarios. Besides handling the care planning, team members practised communicating with each other, with the avatar patient, and with his family.

CREATIVE is more than a novelty. It provides essential training for diverse health professionals in dispensing quality, well-coordinated team-based care, increasingly needed for an ageing population with multiple chronic conditions. Understanding one another's roles and responsibilities forms the basis of their effectiveness as healthcare teams of tomorrow.

Research was completed in 2019, and the programme was introduced to the curriculum for about 600 medical and nursing students in 2020. Being able to overcome different schedules and physical distance will soon be a boon for healthcare students in all six disciplines at the various institutions. Come 2021, they will have the opportunity to Create Real-time Experience And Teamwork In a Virtual Environment.



THE COST OF HEALING

WHAT CONSTITUTES OPTIMAL cost-efficient clinical care for patients? Through mock cases simple and complex, students can test the financial impact of their decisions using a simulation game developed by the School.

HEALING (Health Economics Awareness Learning), available as an iPad game, exposes students to diverse clinical scenarios, a range of demographic profiles, and an array of local payment schemes, just as they would encounter in actual practice.

As students choose what investigations to order and elect management procedures for their virtual patients, they get feedback on the cost and appropriateness of their decisions. Equally important, they also gain familiarity with Singapore's different payment plans with their various categories of charges and subsidies.

This stronger awareness of healthcare economics is expected to guide them in taking wiser options when they eventually enter clinical practice.



New Dimensions in Medicine

The pandemic may have put paid to the clinical and overseas electives, but far from things coming to a dead-end, new pathways have opened up. These Pathway Programmes, drawn mainly from non-medical fields, have led to broader minds and fresh skill-sets. They have encouraged our students to explore beyond the traditional borders of their curricula, to master new domains and to draw them into the realm of 21st century healthcare.

PATHWAY PROGRAMMES

EACH PATHWAY PROGRAMME imparts relevant core knowledge that is reinforced through selective workshops and independent project work, culminating in a scholarly paper or presentation by the time of graduation.

Medical Education—Skills in Teaching and Research (STAR)

Not just competent doctors but able educators and skilled education scholars too—students on this Pathway focus on education innovation on their way to becoming future clinician educators. An exposure to concepts and principles of Health Profession Education prepares them to engage and develop the next generation of medical students.

Medical Innovation and Entrepreneurship

Six Cs carry students who come to this Pathway across challenges in providing healthcare. Curiosity, Creativity, Compassion, Collegiality, Collaboration, and Commercial Intelligence are key to kindling an entrepreneurial spirit and conceiving successful solutions. Modules like Design Thinking and Business Model Innovation, and Practice-Changing Oncology provide the students with real-world scenarios and a global mindset, all the better to tackle any clinical crises to come.

Inquiry and Thinking

Critical thinking and problem solving skills are part of a doctor's arsenal. This Pathway

not only leads students to foster a habit of inquiry, but it also cultivates an appreciation for the way research helps deepen one's understanding of clinical medicine.

Behavioural and Implementation Science

This Pathway takes an inductive approach, combining behavioural insights with empirically-tested results to design interventions, then translating these for the real world through the strategies of implementation science. Learning from leading international experts, students are equipped to effect genuine change that improves and inspires health for all.

Health and Humanity

Students on this Pathway find their way to the heart of medicine. Challenged to rethink their journey as healers, students discover a more profound appreciation of humanity where health and the arts meet. Strong mentoring relationships underpin the programme, with faculty and staff sharing personal narratives to emphasise authenticity and vulnerability. These students will be reflective, resilient practitioners in an intense profession.



Health Informatics

This Pathway brings students to a particular vantage point from which they can visualise clinical data sets with a clearer perspective. Taught in partnership with the Integrated Health Information Systems and the Academic Informatics Office of NUHS, this programme produces medical students who are also data science-competent, able to define clinical questions and identify and analyse relevant data to address issues. Mini-datathons challenge students with real-life, anonymised patient information as they test their analytical skills.

Grand Finale

After three intense months, the six Pathways converged in a live webinar session in May 2020. A showcase of 12 selected projects was presented by the students, with prizes awarded to the top three; attendees were engaged and enthusiastic.

The whole programme, pedagogically without precedent in the School, has proven to be a success. Completely new dimensions to training in the medical professions have been opened; facets reflecting the current needs of society impart a more holistic approach to medical education. Here, core teaching provides a foundation upon which pathway-specific skills are built, by way of collaboration with other faculties. In the process, we have uncovered the manifold talents of our students, who have lived up to the challenge. They have found freedom to harness their abilities and test their resourcefulness. And as they bring novel elements to medical training, they raise the potential of what the School can achieve.



Dr Chen Zhi Xiong
Assistant Dean (Education),
NUS Medicine



Propelled by a Pandemic

The move to initiate a digital transformation in order to meet the educational challenges of the future proved prescient when those challenges came earlier than expected. Just how important the systematic and widespread adoption of technology in medical education became clear. The disruption to conventional teaching on campus because of the COVID-19 pandemic only accelerated the adoption of digitalised learning, and innovation in education software and assessment techniques.

NUS, having formally adopted virtual collaborative platforms, was quick to employ this as a significant mode of teaching so as to continue delivering a high quality of education.

Students were comfortable moving online, and faculty members just as swiftly adjusted to working from home and using virtual classrooms.

ONLINE EDUCATION



NUS MEDICINE FACED the challenge of maintaining the rigour of the curriculum even as infection control measures were put in place. Social bubbles were created, safe distancing was enforced, and the duration of student postings to healthcare institutions was cut by half. In-person classes with more than 50 students could not be held.

But by February 2020, the replacement of face-to-face lessons and clinical attachments was also seen to, via:

- Online learning using webinar platforms for interactive lectures and collaborative learning cases, and virtual patient learning platforms like Entrada and Pathweb.
- New Pathway programmes such as Health and Informatics in place of clinical elective programmes.
- Standardised Patient-based training for history taking and physical examinations, with prepared interpretations of test results, imaging, and management plans.

- Zoom-based training with real patients for history taking and physical examinations, with real-time lab results and imaging for discussion of care plans.
- Case-based discussion ward rounds with real patients, through the review of electronic medical records without direct patient contact.
- Online case-based discussion employing virtual patients.

These together constituted a crucial step forward in ensuring uniformity in learning and allowing students to build a strong foundation.

Sans any precedent in the School in the use of online teaching platforms, the speed and agility of both staff and students in adapting is all the more creditable. The students have been appreciative of these learning opportunities and this is reflected in their increased engagement during teaching sessions—the sheer volume of in-depth questions and relevant ideas put forth using the chat function has created the need for a Teaching Assistant to manage the chats and answer students in real time.

ASSESSMENTS

As for teaching staff, they, too, switched to a more convenient online blended learning format for faculty development workshops, the popularity of which has been demonstrated by a surge in enrolments since the shift.

Away from the screen, students were also able to make the most of the limited period with patients in their clinical postings. Spending more than the usual amount of time every day with the patients, learning from them, has given them deeper insight and empathy.

Indeed, that is among three competences NUS Medicine cultivates which remain unchanged in these times, and which the School believes will prepare students for the challenges ahead as medical practitioners:

- Empathy, based on the School's values of Respect, Integrity, Compassion, and Humility
- Metacognition
- The use of technology, while being situationally aware

In the face of COVID-19, the School endeavours to nurture these competencies and attributes in our students with new-found vigour and urgency.



COVID-19 HIT Singapore just before the final examinations at the School. Assessments planned far in advance suddenly had to change. Government directives and our own controls put us in situations so fluid that we had to adapt to changes daily.

A modified blueprint for examinations was required. For theory exams, when we were allowed on site, we split the cohort into different venues hosting fewer than 30 students each, and ran the exam for the whole cohort simultaneously. When the situation got worse, we employed summative home-based exams with remote proctoring. Some students needed extra support for issues that ranged from resources such as electronic devices and uninterrupted Wi-Fi to even a place to take the exam. Clinical examinations were modified by substituting stations that would have real patients with Standardised Patients, task trainers, and hybrid exam stations.

Dr Dujeepa Samarasekera, Director of the Centre for Medical Education at NUS Medicine, relates, "What shone through was the collegiality of faculty and students as the whole school came together to see it through."

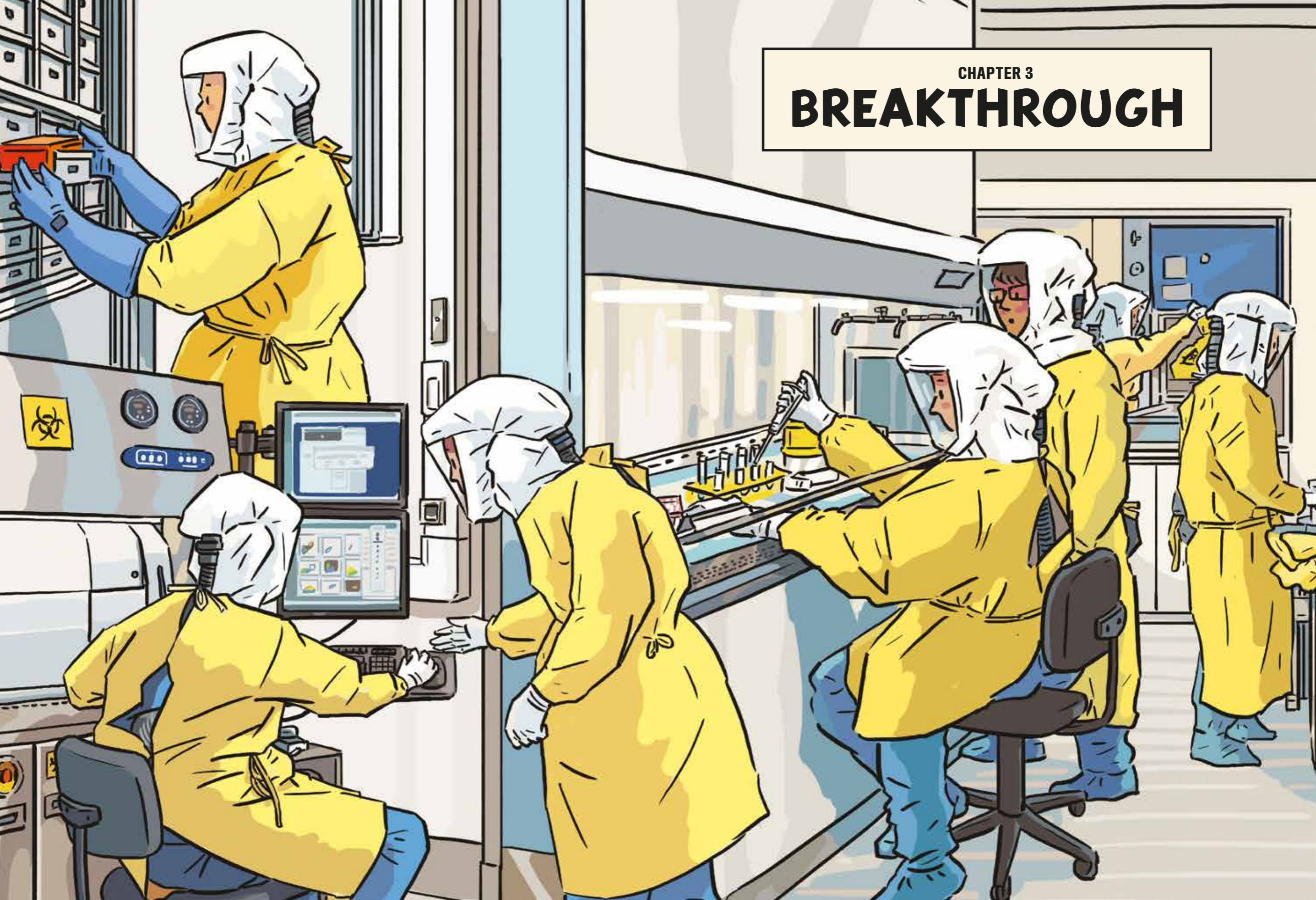
The learning points have been important. The pandemic has given us the opportunity to critically evaluate our processes; we have seen the possibilities. We have done well and, in the long term, we know we will do better.



Dr Dujeepa Samarasekera
Director, Centre for Medical Education (CenMED)
NUS Medicine
National University Health System
Senior Consultant, Ministry of Health Singapore

CHAPTER 3

BREAKTHROUGH



BREAKTHROUGH

THE RACE IS ON

“ Interdisciplinary collaboration in research is the way to go in our race to stay one step ahead of diseases. Our research efforts not only focus on understanding a disease and its treatment but also how we can prevent it.”



Prof Chng Wee Joo
Vice-Dean, Research

“ Traditionally, departments did everything—teaching, research, and service. It was a natural way to organise people, work, and roles. But this tended to lead to compartmentalisation and duplication, especially as the nature of research became more multidisciplinary.

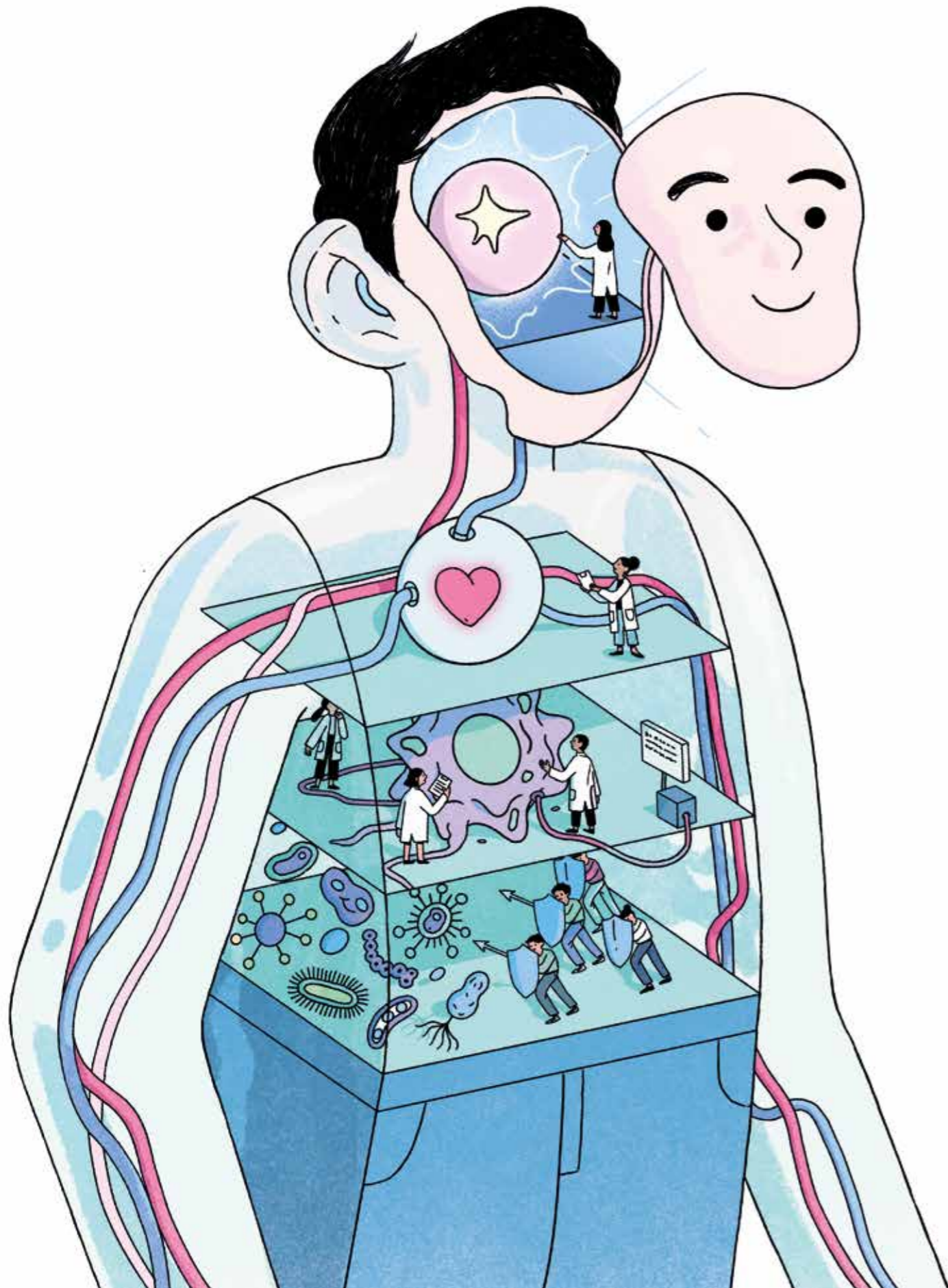
Hence, we decided that departments should focus on teaching and service. Research would be conducted in school-level transdisciplinary programmes, where the concentration of talent and resources, as well as diversity of approaches, will lead to greater synergy and cross-pollination of ideas. By placing the emphasis on teaching in departments and research in programmes, we reinforced both our key missions of education and research, while enabling greater levels of competitiveness, innovation, and excellence. ”



Prof Chong Yap Seng
Dean, NUS Medicine

Since July 2019, the School has reorganised our research structure with an emphasis on translational research that helps to improve health and well-being. The nine Translational Research Programmes (TRPs) were also strategically selected with a focus on meeting the current and projected healthcare needs of our population.

Each TRP is directed by a lead scientist and a clinical lead who manage the core funding for the programme to attract collaboration of expertise and development of facilities. The TRPs bring together researchers from different departments and faculties for greater collaboration and synergy to maximise resources. The flexibility of the TRPs also allows research to evolve to meet changing needs.



Looking Where It Counts

Five health-focused TRPs were identified in AY2020. The emphasis of these TRPs is on areas relevant to Singapore and other Asian communities in the region, and beyond.

CANCER

THE CANCER TRP, also NUS Centre for Cancer Research (N2CR), hopes to develop new ways to detect, cure, and prevent cancer through internationally leading fundamental research. The programme aims to advance our understanding of cancer, and translate research discoveries into clinical practice that benefits patients.

The programme's emphasis on interdisciplinary collaboration will bring fundamental researchers in biomedical sciences together with scientists and engineers to develop enabling technology to address major scientific or clinical challenges. Site-specific resources offered by the programme include the collection of patient samples or databases with clinical information.



Prof Ashok Venkitaraman
Head, Cancer TRP

“Cancer is a leading cause of death and illness worldwide, and currently represents a growing challenge in Singapore. We hope that our research programme allows us a better understanding of the cause of cancer that results in earlier detection and treatment, or even prevention. Hence, the hallmark of our programme is its three cross-cutting themes of tissue-specific carcinogenesis, precision cancer medicine, and early cancer intervention.”

CARDIOVASCULAR DISEASES

CARDIOVASCULAR DISEASES (CVD) is widely recognised as the top disease burden locally and internationally, accounting for approximately 30% of local deaths to date. Research has shown that Singaporeans suffer from the onset of CVD at a younger age than westerners—up to 10 years younger. In addition, the 5-year death rate from heart failure is approximately 50%, significantly higher than even some well-known cancers.

“CVD research has consistently received less global funding than it deserves. In 2018, only one medicine was approved by the Food & Drug Administration (FDA) for CVD versus 16 drugs for cancer. NUS Medicine saw the need for CVD research on new drugs and treatment approaches.”



Prof Roger Foo
Head, Cardiovascular Disease TRP
Zayed Bin Sultan Al Nahyan Professor in Medicine

HEALTHY LONGEVITY

SYNERGISING BASIC AND clinical sciences, scientists and clinicians in the programme investigate the multifaceted aspects of ageing. The programme focuses on promoting the development of biomarkers to measure ageing, testing interventions to slow ageing, and creating personalised implementation strategies to extend healthy life expectancy in Singapore.

“Singapore’s population is ageing rapidly, hence there is an urgent need for more efforts to promote healthy longevity. The Healthy Longevity TRP aims to provide a more comprehensive understanding of the biology of ageing so we can add healthy years of life by delaying ageing, prolonging disease-free life, and enhancing quality of life.”



Prof Brian Kennedy
Head, Healthy Longevity TRP



Scan here for the webinar series

HUMAN POTENTIAL

THE HUMAN POTENTIAL TRP adopts a holistic perspective that considers human potential as an integrative measure of health, productivity, performance, human capital, and overall well-being during a person's lifetime.

By developing evidence-based strategies to enhance human potential, and metabolic and brain health, the programme aims to maximise physical and cognitive performance in the changing environment. Its emphasis is on physical and emotional development in early life and other periods of life to boost work productivity and performance to optimise the potentials and abilities of Singaporeans.

“The study of human potential is increasingly being recognised as an important field to better understand how we can improve health and performance throughout the life course. Our research findings can positively impact not only the current workforce in Singapore, but also future generations.”



Prof Johan Eriksson
Head, Human Potential TRP



INFECTIOUS DISEASES

FOCUSING ON ASIAN-CENTRIC infectious diseases endemic and relevant to Singapore and the region, the programme aims to look at aspects ranging from detection, education, and communication, to prevention, transmission, and treatment.

The research expertise and areas of the Infectious Diseases TRP are grouped into three broad themes. They are pathogen evolution and transmission, host-microbe interactions, and vaccine and therapeutics.

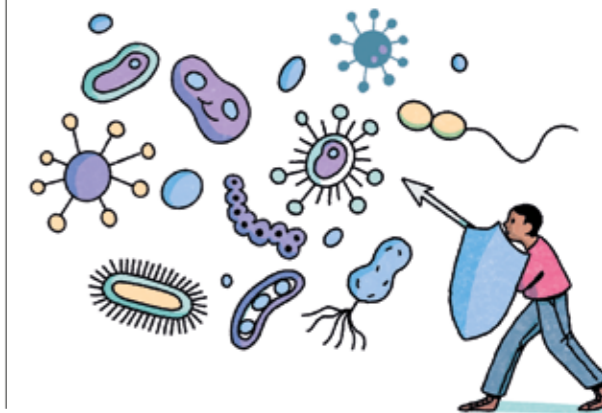
“Even before the COVID-19 pandemic, NUS Medicine had already identified Infectious Diseases as an important clinical research area. The current pandemic is a stark reminder of the relevance and significance of the Infectious Diseases TRP. Our Asian-centric focus aims to help us better understand the impact of diseases on Asians so that we can offer better treatment options to patients. Our programme is not only studying known diseases but also gearing up for further disease outbreaks of the future.”

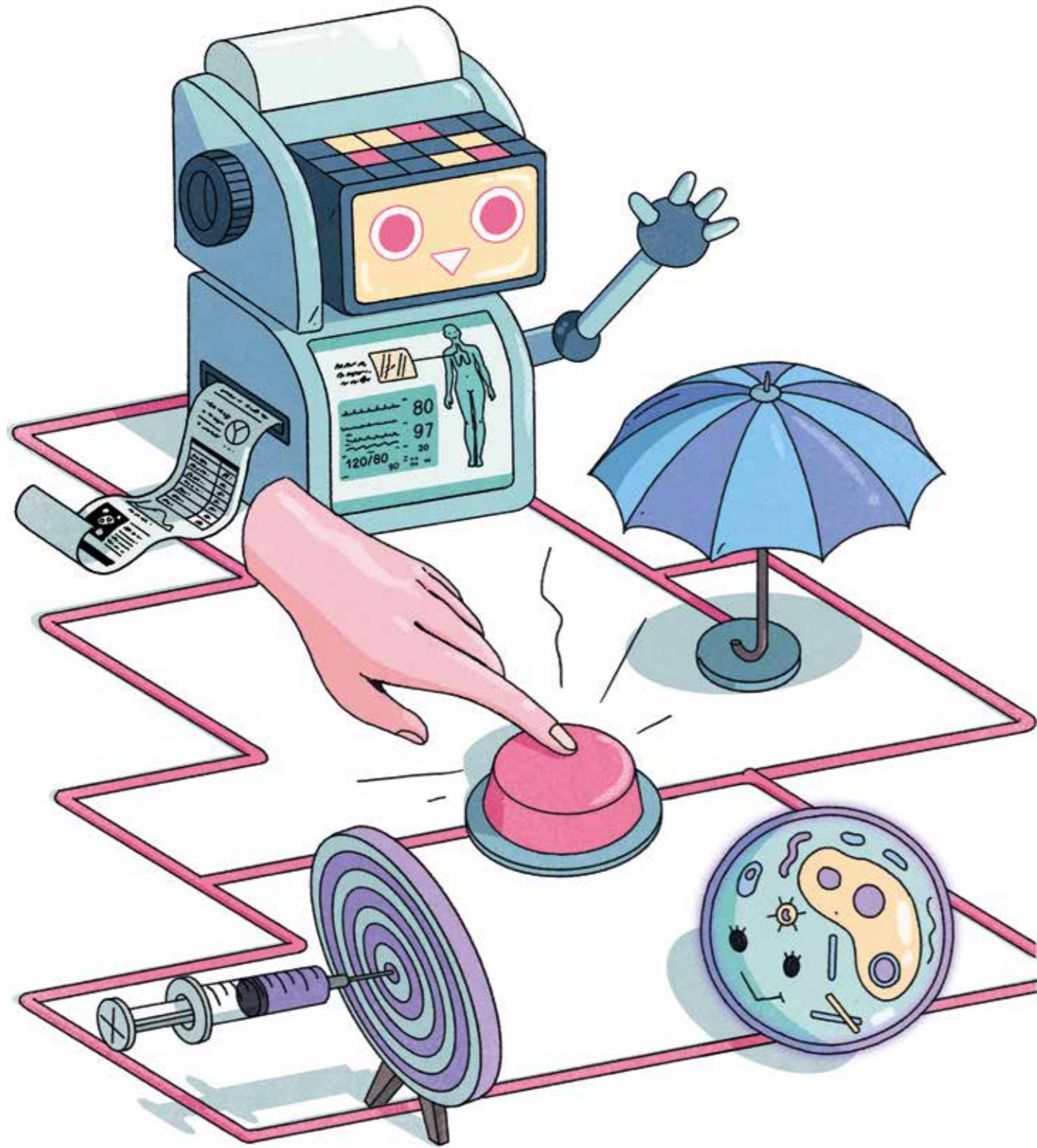


Assoc Prof Gan Yunn Hwen
Co-Head, Infectious Diseases TRP



Assoc Prof Sylvie Alonso
Co-Head, Infectious Diseases TRP

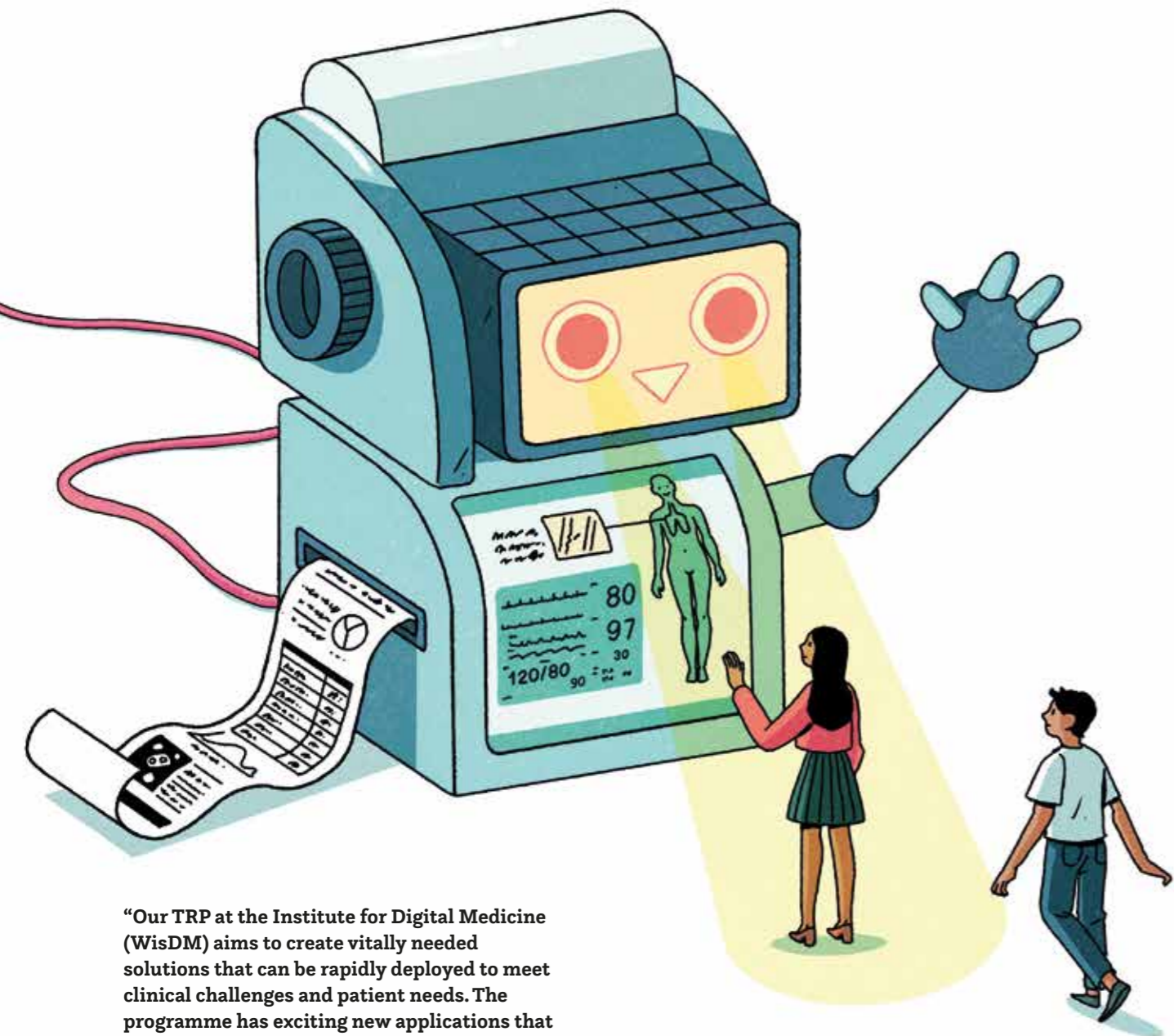




Making Strides with Strategic Research Platforms

Four strategic platform-focused TRPs were launched during the year, bringing together science and technology to support multiple areas of health and disease.

DIGITAL MEDICINE AND ARTIFICIAL INTELLIGENCE (AI)



“Our TRP at the Institute for Digital Medicine (WisDM) aims to create vitally needed solutions that can be rapidly deployed to meet clinical challenges and patient needs. The programme has exciting new applications that promise to transform global healthcare and implementation.”



Prof Dean Ho
Head, Digital Medicine and AI TRP

SYNTHETIC BIOLOGY

THE SYNTHETIC BIOLOGY TRP (SynCTI, Synthetic Biology for Clinical and Technological Innovation) aims to develop highly customised cells imbued with biological precision and cellular autonomy to meet the specific aims of treating diseases, promoting healthy living, and restoring planetary health.



Key TRP themes

- **Therapeutic cells vs human diseases –** Understand and develop therapeutic cells that autonomously modulate gastrointestinal homeostasis in response to disease states so as to restore normalcy.
- **Functional foods for healthy living –** Understand and develop functional, next-generation foods that promote health and prevent disease through biological and clinical innovation.
- **Sustainable biomanufacturing for planetary health –** Understand and develop biological systems that enable sustainable manufacturing of biomolecules for use in medicine and biotechnology.

“The Synthetic Biology TRP (SynCTI) seeks to repurpose biology for positive clinical impact and aims to harness synthetic biology principles to improve health and treat diseases.”



Assoc Prof Matthew Chang
Head, Synthetic Biology TRP

THE TRP AIMS to create digital solutions together with the larger NUS community for scalable patient impact.

Key TRP themes

- **WisDM.CTI (Clinical Trials Innovation)** aims to harness AI to realise novel clinical trial designs for new drugs and devices. Currently, first-in-kind human trials have been cleared to start at multiple hospitals.
- **WisDM.Tx (Therapeutics/ Interventional)** optimises N-of-1 (single subject) drug and software-based treatment with digital medicine. While multiple trials have been cleared, new trials are underway.
- **WisDM.Dx (Diagnostics/ Wearables)** develops clinical studies of wearables for cardio health and prenatal care. Pilot clinical studies are currently being developed.
- **WisDM.Data (Data Infrastructure)** deploys infrastructure to drive the implementation of digital medicine. Data infrastructure has been established and studies are underway.
- **WisDM.Enable** drives all healthcare economics assessments of WisDM.Tx and WisDM.Dx trials to ensure that WisDM technologies and healthcare operations optimisation programmes are geared towards adding sustainable value to the healthcare community.



IMMUNOLOGY

THE PROGRAMME AIMS

to develop more effective immunotherapy, new treatment guidelines, and diagnostic tests for patients with disease-specific problems such as cancer, organ/tissue transplantation, and autoimmune, airway, and infectious diseases.

Key TRP themes

- **Immune homeostasis** – Gain a better understanding of the role of the immune system in health and diseases and how the human immune system is regulated.
- **Immunotherapies** – Develop and deliver innovative immune-based therapies to patients.
- **The Asian immunophenotype and clinical investigations** – Identify novel approaches to diagnose, guide treatment, and measure therapy efficacy through the investigations of immunological phenotypes and mechanisms that are relevant for the Asian populations in infectious and airway diseases, oncology, autoimmunity, regenerative medicine, and transplantation.
- **High-throughput genetic sequencing, high-dimensional flow cytometry and multi-parameter histology** are technologies employed to characterise the Asian traits of the immune system of our population groups.

“The Immunology TRP studies how the human immune system is regulated in health and diseases to harness its power to treat and diagnose a wide range of diseases. By fostering collaborative research, we aim to advance the latest technologies to probe immunological mechanisms, and enhance infrastructure for clinical translation.”



Assoc Prof Veronique Angeli
Head, Immunology TRP



PRECISION MEDICINE

PRECISION MEDICINE IS

defined as an approach that combines molecular data at systems scale level (e.g. omics of genes, proteins, lipids, sugars, etc.) with environmental, lifestyle, and healthcare data to optimise health and improve disease management. Large studies have successfully identified hundreds of novel loci associated with numerous diseases providing a “map” of the locations in the genomes relevant to various disease states and clinical contexts.

The programme aims to identify therapeutic targets that can be modulated by novel strategies to treat or prevent disease. This approach is based on the belief that human genetics has the potential to accelerate the healing process through the modulation of the specific target even before any treatment begins.

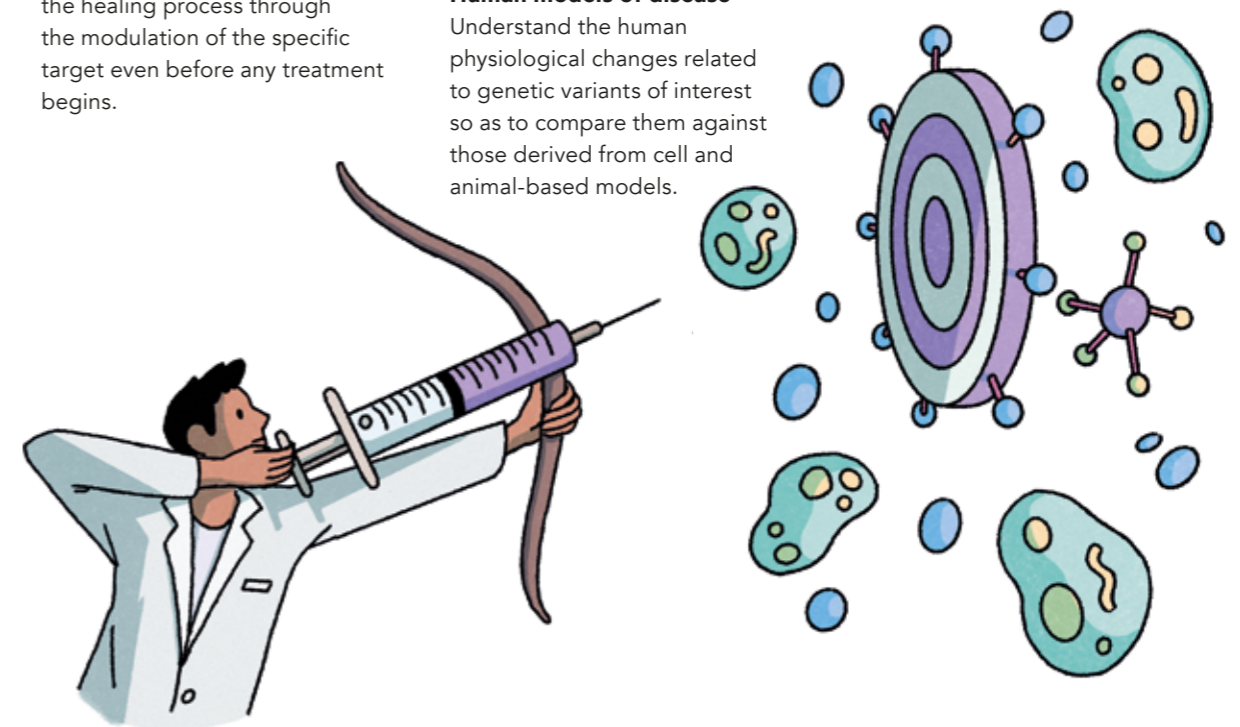
“Basically, precision medicine applies human biology to disease treatment using the best dose or drug combination for one’s genome. Since the success of early genome sequencing, interest in precision medicine has been growing. This is especially so with the advances of technology platforms such as next-generation sequencing, which allows profiling of populations at a scale and cost now affordable in many countries.”

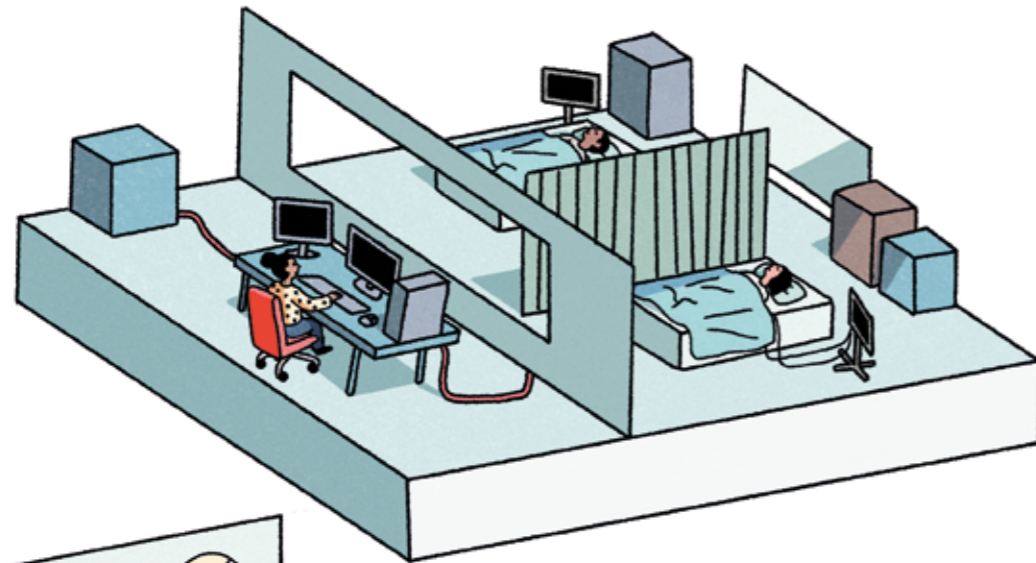


Prof Markus Wenk
Head, Precision Medicine TRP

Key TRP themes

- **From maps to mechanisms** – By leveraging on the basic science capabilities, the TRP has developed a number of strategies that will allow the identification and validation of molecules that can serve as therapeutic targets for novel therapies.
- **Human models of disease** – Understand the human physiological changes related to genetic variants of interest so as to compare them against those derived from cell and animal-based models.
- **Modifying the natural history of disease** – The TRP brings together clinicians and scientists to develop therapeutic strategies based on novel therapies or novel diagnostics identified through the programme to create impact on health and disease.





New Research Centres

In addition to the TRPs, NUS Medicine launched three new research centres on 1 July 2019. The centres' Asian-focused research takes a forward-looking approach to enhancing human potential and improving health.

CENTRE FOR BEHAVIOURAL AND IMPLEMENTATION SCIENCES INTERVENTIONS (BISI)

LEADING BEHAVIOURAL EXPERT

Prof David Halpern and implementation science expert Assoc Prof Robyn Mildon are co-leads in the design and set-up of a multidisciplinary centre that aims to improve population health and well-being.

BISI aims to accelerate the use of behavioural and implementation science in health and public health systems through developing expertise in four key areas.

- **Education** – Develop curriculum for foundational learning as well as formalise the Behavioural and Implementation Science Track. Pilot workshops were held in May 2020 and July 2020 for its undergraduate students.
- **Faculty development** – Equip our doctors and educators

with skill sets to either teach or gain proficiency in a new area of interest; attract scientists interested in this field, and funding from philanthropists; cultivate potential partnerships that provide a path for career advancement; and enable greater collaboration.

- **Lifelong learning** – Introduce the Behavioural and Implementation Sciences programme suite for in-house executive education.
- **Further development** – Include advanced aspects of psychology, machine learning, and data science.

“Behavioural science is the study of understanding, predicting, and influencing human behaviour. Implementation Science is the study of methods to promote the adoption, implementation, and sustainment of evidence-based practices and policies in routine healthcare and public health systems. Together, these rapidly evolving disciplines share the ultimate goal of improving the quality of healthcare. With the set-up of BISI, we hope to establish a Singapore-based global leader in Behavioural and Implementation Sciences in healthcare systems.”



Prof David Halpern
Co-director, BISI



Assoc Prof Robyn Mildon
Co-director, BISI

CENTRE FOR SLEEP AND COGNITION

THE CENTRE FOR Sleep and Cognition aims to fill the gap between knowledge creation and practice, and, in the process, contribute to unlocking human cognitive potential. The centre takes a multidisciplinary approach to translate research on sleep and human cognition.

- The centre aims to
- Help Asians optimise sleep for better well-being.
 - Maximise cognitive abilities to improve learning and health from childhood through adulthood.
 - Harness large datasets to understand and positively influence human behaviour and health, with particular focus on reducing cognitive decline in the elderly.

“We believe that the potential in modulating behaviour to transform lives has not been sufficiently exploited. We all desire to increase productivity but Asians have a tendency to emphasise increased effort over behavioural solutions. Hence, there is a need for translational research in human cognition.”



Prof Michael Chee
Director, Centre for Sleep and Cognition

CENTRE FOR HOLISTIC INITIATIVES FOR LEARNING AND DEVELOPMENT (CHILD)

A COLLABORATION

BETWEEN the Lien Foundation and NUS Medicine saw the establishment of the Centre for Holistic Initiatives for Learning and Development (CHILD). Together with our partners, the Centre for Evidence and Implementation (CEI) and Singapore Institute for Clinical Sciences (SICS), we will bring together leading researchers, clinicians, and practitioners in the field of early childhood development.

The Centre aims to improve the lives of children and families in Singapore, especially those who are vulnerable, with a focus on the emotional, cognitive, and social well-being of children from conception to their early primary school years.

“There is increasing awareness of how early childhood development impacts the different aspects of human life. Our Centre will benefit from a convergence of talent, data, knowledge, and expertise in early childhood development through our multidisciplinary collaboration. While the focus of our centre will be Singapore-centric in the first five years, we aim to be a leading centre in Asia for child health and development, capable of accelerating the implementation of cutting edge research into policy and practice in the region.”



Prof Lee Yung Seng
Director, Centre for Holistic Initiatives for Learning and Development (CHILD)

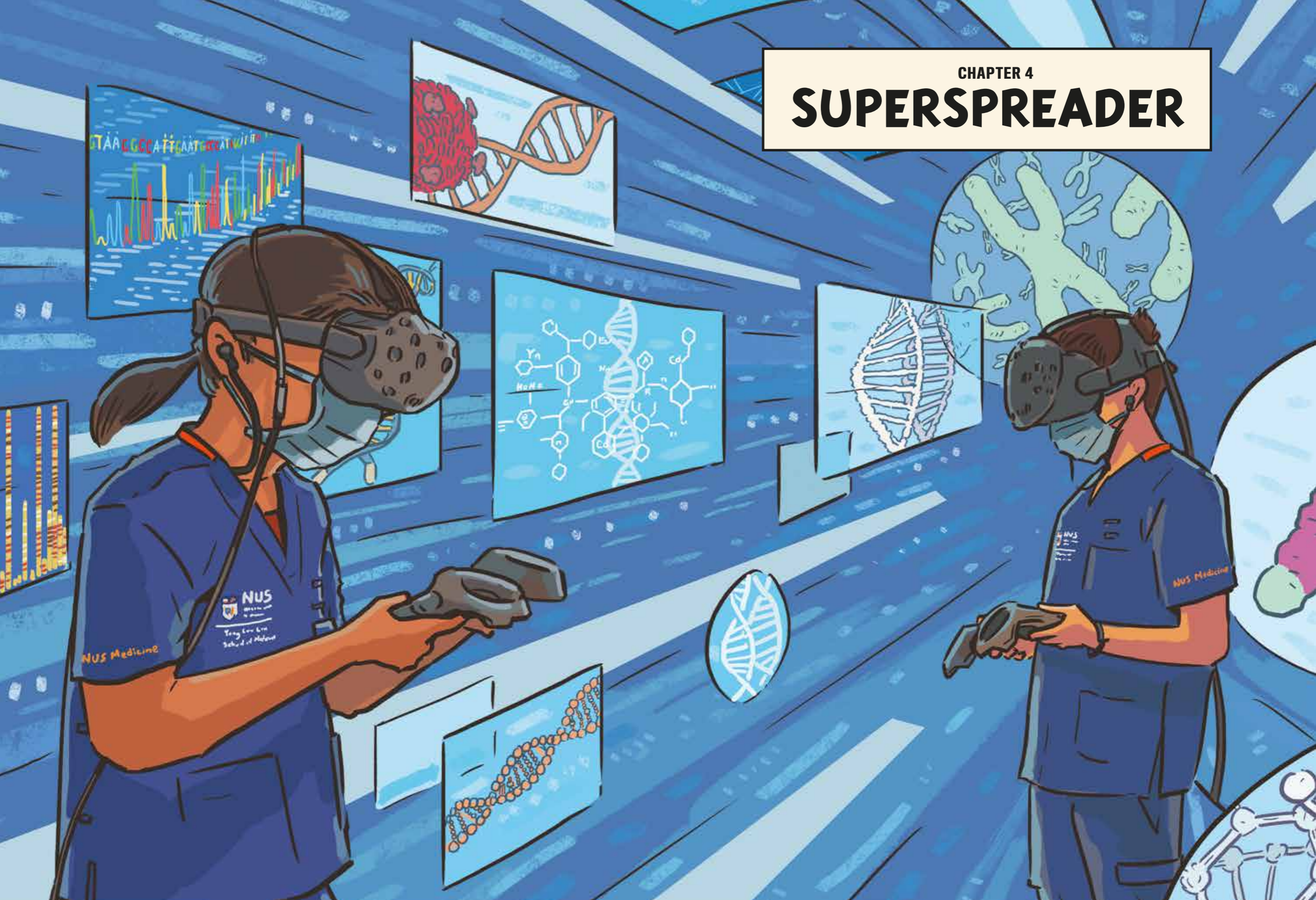
Working in close partnership with other organisations, the Centre is committed to driving significant, evidence-based changes guided by data directly relevant to and drawn from Singapore.

By accelerating the synthesis of evidence in early childhood

learning and development policies and practice, the Centre will contribute to knowledge and best practice in this field. It will research methodologies for early screening of preschool children as well as needed interventions to give them the best start for school.



CHAPTER 4
SUPERSREADER



SUPERSREADER

A RASH OF INSPIRATION

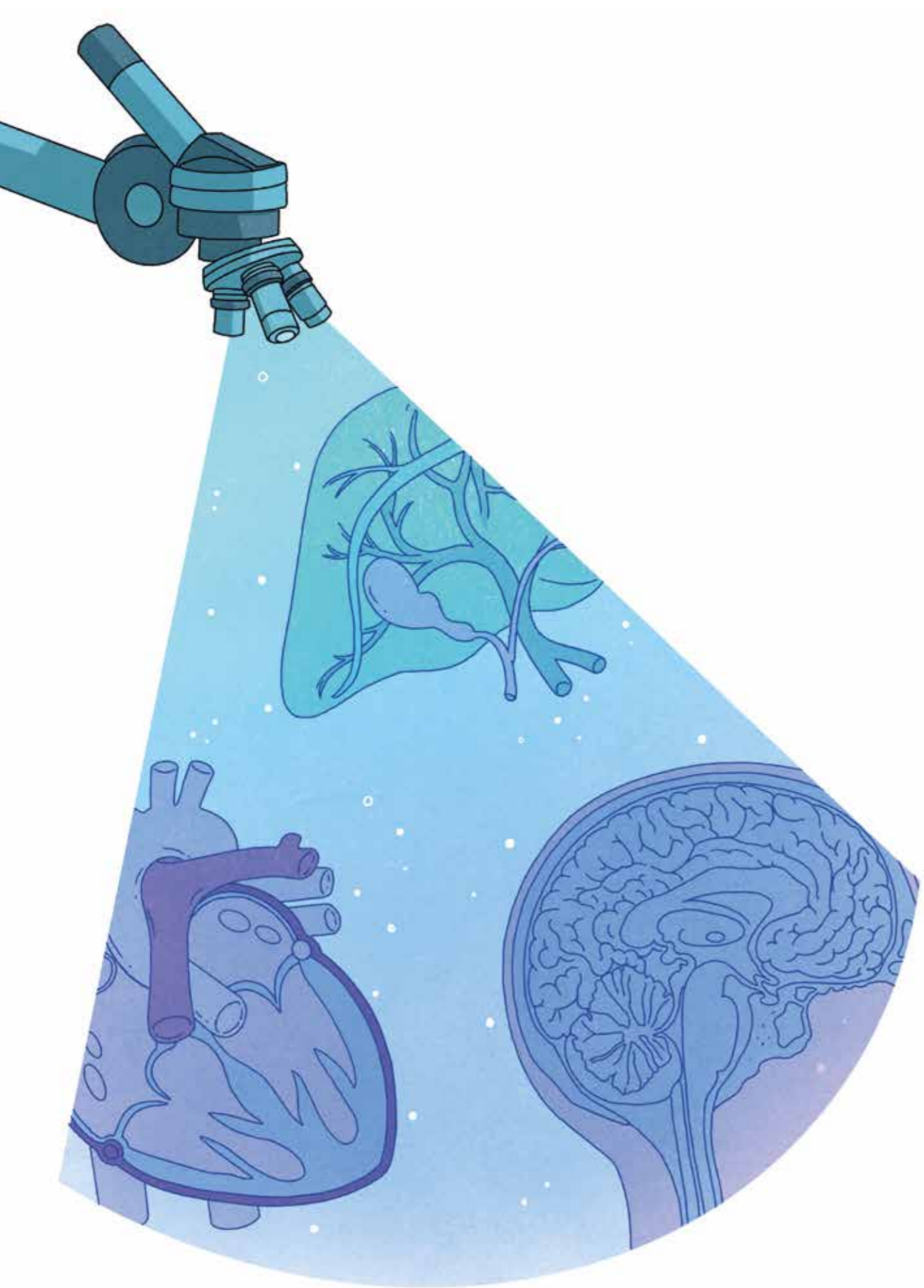
“Always ask why we can’t do things better.
That’s how we innovate.”



Prof John Eu-Li Wong
Senior Vice President (Health Innovation & Translation),
NUS

In inspiring research and innovation, we encourage curiosity in our students, creativity in our faculty and resilience and agility for all. We focus not only on filling gaps in healthcare solutions to diseases and medical conditions, but we also look to the future of improving health and being pandemic-ready. This approach is especially critical in today’s rapidly-changing environment.

At NUS Medicine, our translational research approach focuses on taking discovery science to the next level of application, implementation, and practice in as much of a real-world setting as possible. Our School’s strengths in harnessing health technology have helped us achieve both medtech and biotech innovations in 2020.



Medtech

With our strong research background, the School has been driving healthcare innovation and developing medical technology to diagnose, treat, and improve health and well-being. Our innovative solutions aim to help meet the healthcare needs of Singapore and inspire health for all.

SYNAPSE – FASTER, CRYSTAL CLEAR BRAIN IMAGING

SYNAPSE WILL ENHANCE our understanding of the circuitry and structure of the brain, clarifying normal functions and helping to identify the causes of brain diseases. The study links the synchrotron facilities in the Asia-Pacific region and is expected to involve more than 1,000 researchers.

Formalising the collaboration, the founding members of the SYNAPSE initiative signed two Memorandums of Understanding (MOUs) on 15 January 2020. The first MOU was to launch SYNAPSE and agree on completing the massive brain map project by 2024. The second MOU launched the implementation of a high-performance computing network to process, store, mobilise, access, and analyse at high speed the study data.

The SYNAPSE team will produce a first-of-its-kind ultra-high-resolution 3D comprehensive map of the neural network of the human brain. The collaboration involves teams from Singapore, Japan, South Korea, and Taiwan while Australia and China have also expressed interest to join the project.

Initiated and developed at NUS, the Singapore team including researchers from the Singapore Synchrotron Light Source (SSLS) will use synchrotrons—extremely

“With the growing number of neurological neurodegenerative pathologies worldwide such as Alzheimer’s disease and other forms of dementia, better diagnostics and treatment options are greatly needed. The new SYNAPSE imaging technique uses powerful X-ray technology that will provide us with clear and detailed images of the brain to aid development of more effective treatments.”



Assoc Prof Low Chian Ming
Department of Pharmacology, Department of Anaesthesia
Co-Founder, SYNAPSE
SYNAPSE Lead, Singapore
Executive Board, SYNAPSE

Assoc Prof Low is one of the co-founding members of the international collaboration called Synchrotron for Neuroscience – an Asia-Pacific Strategic Enterprise (SYNAPSE), and leader of the Singapore team.

powerful X-ray sources—to trace the complex and intricate networks that cover the brain. Besides working on constructing the map of the human brain, the Singapore team is responsible for coordinating the data management for the study.

SYNAPSE will complement the structural map constructed from x-ray imaging with subcellular and molecular information from other advanced imaging techniques such as infrared spectromicroscopy, super-resolution three-dimensional microscopy, and cryo-electron tomography. This coordinated approach will provide ultra-small structural details of the entire brain, analogous to the detailed features of Google Earth images. By contrast, other current maps of the human brain only capture certain specific areas.



The National Supercomputing Centre (NSCC), which has been very supportive of the SYNAPSE initiative, is the Singapore representative for the High-Performance Computing network. Singapore will leverage the petascale supercomputing resources at the NSCC, and serve as the data hub of SYNAPSE. The data hub will link all the SYNAPSE partners via the established high-speed 100G international network connections of the Singapore Advanced Research and Education Network.



Scan here to watch a video clip on the project

FATTY LIVER CONDITIONS

FATTY LIVER IS common, affecting about 40% of our population, and is an important emerging health problem. Non-Alcoholic Fatty Liver Disease (NAFLD) can progress to Non-Alcoholic Steato-Hepatitis (NASH), and ultimately, result in liver cirrhosis. NASH is a silent, potentially life-threatening disease strongly associated with an increase in obesity, diabetes, and cardiovascular diseases. At present, adequate diagnosis and therapy are lacking. In order to reverse liver damage in the early stages, it is essential to be able

to detect and treat fatty liver conditions early.

The medical application of nanotechnology, such as the development of the nanomedicines studied by the research team, is focused on nano-diagnostics for diagnosis of the different stages of liver disease, and nano-therapeutics for treatment of fatty liver conditions in the early stages. The team’s research innovations are the result of collaboration between basic and applied scientists and clinicians.

“Currently, diet and weight control are the only recommendations for patients as no treatment is available and diagnostic tests are unreliable during the early stages of liver disease. The ideal solution is for us to find a way to reverse NASH and have better diagnostic tools for early detection.”



Prof Lee Chuen Neng
Co-Lead Principal Investigator
Senior Consultant, Cardiac, Thoracic & Vascular Surgery, National University Heart Centre, National University Hospital

“In the project NanoNASH, we use nanotechnology to create nanoparticles to serve as a basic delivery platform for novel treatments and diagnostics of NASH. Nanoparticles carrying drugs and imaging materials accumulate in the liver minutes after injection. Hence, they can help us not only to diagnose, but also to image and stop the progression of inflammation, and decrease NASH-associated hepatotoxicity.”



Prof Gert Storm
Co-Lead Principal Investigator
Department of Pharmaceutics, Faculty of Science, Utrecht University
Visiting Professor, Department of Surgery, National University Hospital

NEW BIOMARKERS PREDICTING HEART FAILURE AFTER A HEART ATTACK

IN A STUDY involving about 700 patients from Singapore and New Zealand who had experienced heart attacks, or myocardial infarctions, the team applied two state-of-the-art technologies to identify new biomarkers of heart failure after a heart attack.

1. Aptamer-based proteomics –

These use short deoxyribonucleic acid (DNA) strands called aptamers to simultaneously measure more than a thousand proteins in blood. As this protein-profiling technology is very sensitive, it is able to detect with high certainty even minute quantities of individual proteins.

2. Single-cell transcriptomics –

These use a technology called single-cell ribonucleic acid (RNA) sequencing. This tool analyses the RNA content of single cells one at a time, instead of using the more conventional method of analysing RNA from large groups of cells in bulk. In this way, the team was able to detect subtle but important changes in RNA expression in subpopulations of cells that would otherwise be missed with a bulk cell approach.

The team next identified as high-priority six proteins for further research to confirm that they were reliable biomarkers of heart failure in patients who had myocardial infarctions.

The team is now developing clinical-grade tests with NUS Biomedical Scientists Engineers to measure the proteins for

user-friendly detection. They are also testing to see if modifying the effect of these proteins can accelerate recovery of heart function after a heart attack.



Scan here to watch a video clip on the project

“A heart attack may damage or stiffen the heart, leading to a condition called heart failure. Identifying patients who are at high risk of developing heart failure can enable doctors to intervene earlier and perhaps prevent heart failure. However, accurate prediction of who will actually develop heart failure after a heart attack can be challenging.”



Assoc Prof Mark Chan
Principal Investigator
Senior Consultant, Department of Cardiology,
National University Heart Centre

“Our research team combined two powerful new technologies to help accelerate the identification of new biomarkers and potential treatment targets to prevent heart failure after a heart attack.”

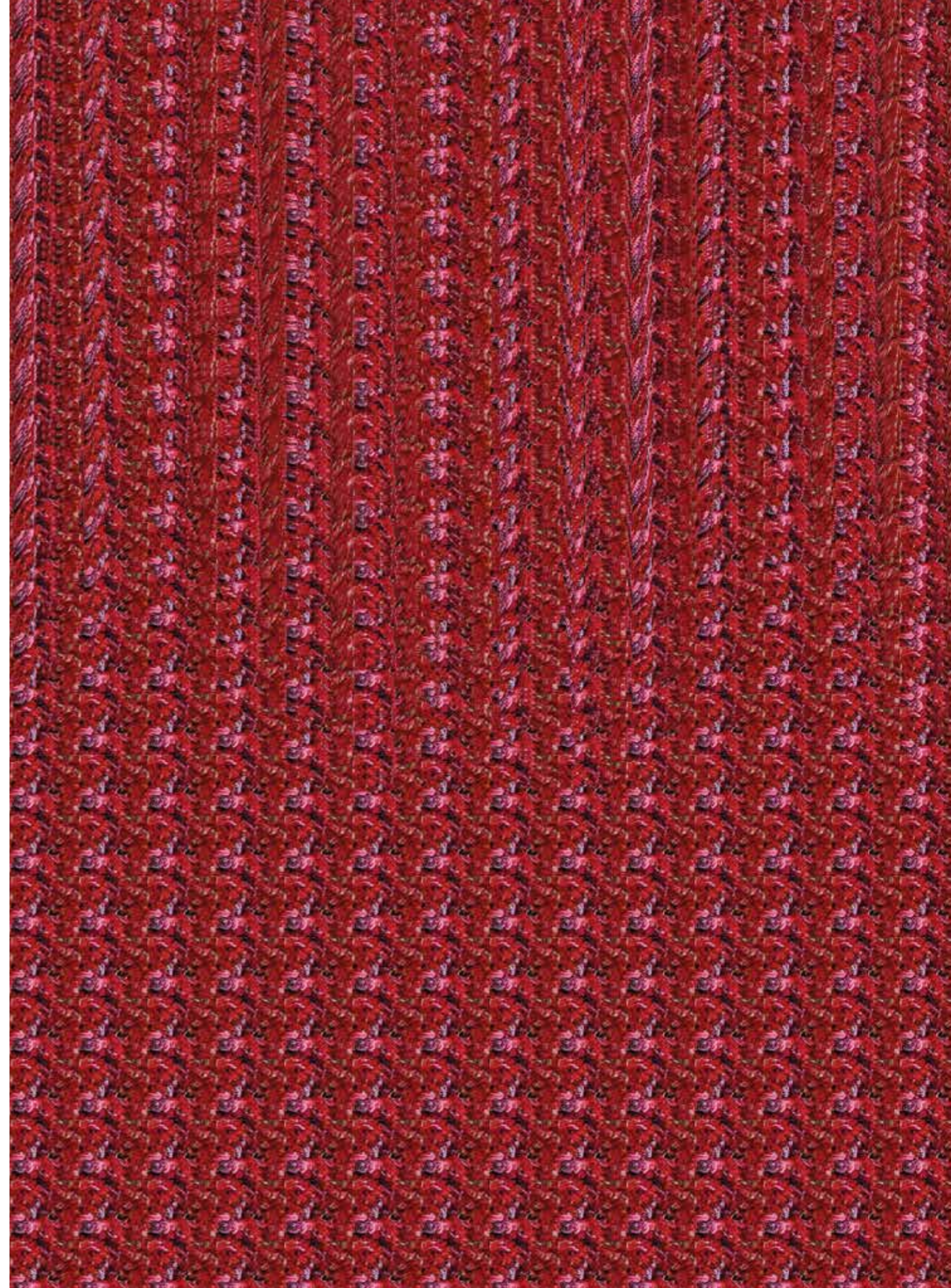


Prof Mark Richards
Study Chairman
Senior Consultant and Deputy Director,
National University Heart Centre

BRAIN EXERCISE! CAN YOU SEE THE HIDDEN IMAGE IN THIS MAGIC EYE PUZZLE?

Magic Eye puzzles or stereograms use 2D pictures to create 3D images. See if your brain can work out the depth information of the image from the repeating pattern encoded in the puzzle.

Hint: Try holding the image right up to your nose so it gets blurry. Then focus as though you are looking through the image into the distance before pulling away. If you're successful, a three-dimensional image should appear in the stereogram.



CARDIOLOGY: GENETIC MAP OF THE HEART



TO BETTER UNDERSTAND the genes in the heart, the research team has developed the first heart genomic ‘connectome’. The connectome serves as a map of the genes in the heart and the ‘switches’ that connect to and control the genes. The map not only shows the location of the ‘switches’ but also pinpoints the most important ones for each gene.

In addition, the team found that a series of 59 new genetic variants influence key switches for particular genes and may play an important role in gene functions in heart diseases. The connectome also helps to make sense of the human genome by

“Heart disease is a complex set of diseases influenced by many different genes. To find out the genetic basis of such complex diseases, researchers study how different parts of the genome interact physically with one another inside a nucleus. This is, however, extremely challenging as the human genome is incredibly vast.”



Prof Roger Foo
Lead Principal Investigator
Zayed bin Sultan Al Nahyan Professor in Medicine, Department of Medicine
Senior Consultant, Division of Cardiology, National University Heart Centre,
National University Hospital
Assistant Dean (Research), NUS Medicine

highlighting the sections and interactions relevant for various organs, such as the heart.

The team’s work makes it possible to analyse the functions of the entire genome and has identified new genes associated with heart diseases. These genes

will now be tested to see if they are targets for the development of novel treatments.



Scan here to watch a video clip on the project

ALZHEIMER'S DISEASE: AMYLOID PET

THE TEAM'S RESEARCH

study of cognitive impairment and dementia focuses on Asian phenotypes of dementia and cognitive impairment due to neurodegeneration and cerebrovascular diseases. The team’s innovation in molecular neuroimaging, in particular, amyloid positron emission tomography (PET), has been particularly useful in diagnosis, prognosis, drug discovery, and monitoring of disease treatment.

With new imaging tracers, the team is able to investigate the natural history of individuals with a high amyloid PET burden. The team’s innovative multi-modal studies including clinical and neuropsychological

assessments, brain, cardiac, and retinal imaging has allowed further insights into mechanisms and potential treatments. These include the identification of molecular pathology in vivo, selection of patients for anti-amyloid clinical trials, and assessment of the contributions of other pathologies to progression.

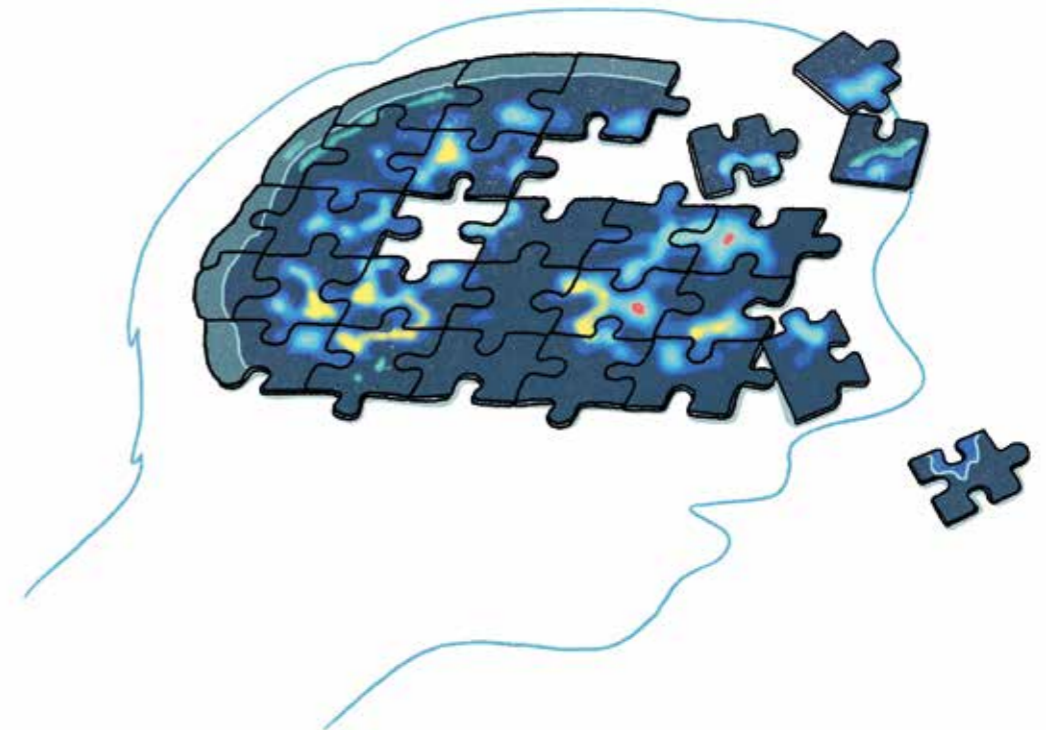
Research themes

- Biomarker discovery and disease mechanisms
- Neuroimaging such as the magnetic resonance imaging (MRI), retinal, and PET
- Clinical trials
- Epidemiology

“We first captured in 2016 images of a protein called amyloid, which is found in the brains of patients with Alzheimer’s disease, using novel brain scans. We have since used this neuroimaging capability to help us diagnose and treat the wide spectrum of Alzheimer’s disease.”



Assoc Prof Christopher Chen
Lead Principal Investigator
Departments of Pharmacology and Psychological Medicine
Director, Memory Ageing & Cognition Centre
National University Health System



MALARIA: IN-VITRO CULTURE

MALARIA IS A vector-borne disease of significant health concern in many parts of the world. Malaria can be caused by several parasites from the *Plasmodium* genus. The *P. falciparum* and *P. vivax* species are of clinical importance because of the high mortality and morbidity rates they cause, respectively. To facilitate research, malaria parasites have to be cultured in the laboratory. While *P. falciparum* does well in in-vitro cultures, *P. vivax* does not.

Researchers are still seeking to understand the invasion mechanism of cells by the *P. vivax* parasite. As the parasites invade selectively a minute population in the blood, nascent red blood cells known as the reticulocytes, the establishment of its in-vitro culture is made more difficult.

To get around this problem, Assoc Prof Juan Pablo Bifani collaborated with New Zealand's University of Otago, and other institutes, to develop an in-vitro culture system for studying *P. cynomolgi*, the simian malaria parasite that most closely resembles *P. vivax*.

By using the blood-stage culture of *P. cynomolgi*, malaria researchers can, for the first time, study the development of the *P. vivax*-like malaria at each stage of its life cycle. These studies were previously made possible only either from infected patients or infected laboratory monkeys.

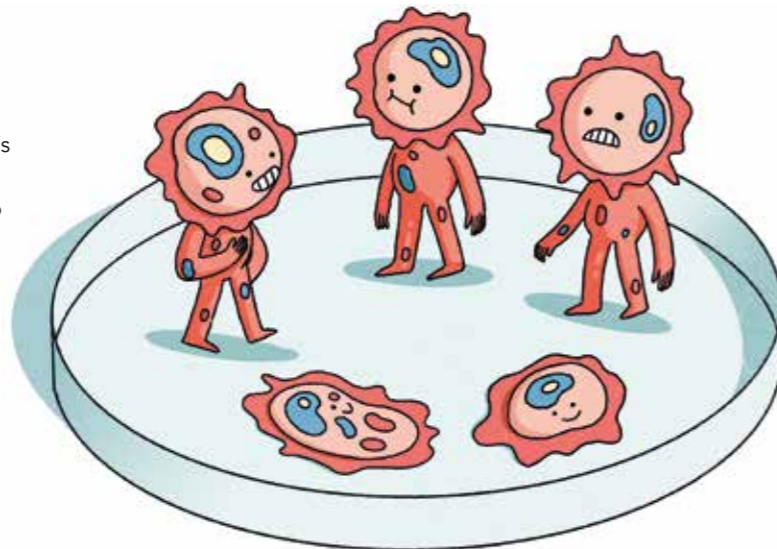
The team is currently working with international collaborators,

using the *P. cynomolgi* culture system as a platform to better understand the biology of *P. vivax*. With the global rise in drug-resistant *P. vivax*, it is critical for researchers to not only gain a better understanding of how *P. vivax* develops resistance to drugs, but also for novel anti-malarials to be identified.

“Our development of an in-vitro culture system to study the *P. vivax* parasite has given us a new tool to fight malaria. Our culture system and protocols have been shared with laboratories worldwide. We hope our findings and collaborative efforts can refine the drug discovery process against *P. vivax*.”



Assoc Prof Juan Pablo Bifani
Principal Investigator
Department of Microbiology & Immunology, and Research Director,
Infectious Diseases Programme
A*STAR Infectious Disease Labs, A*STAR



Biotech

Besides medtech advancements, the School has been developing biotechnology solutions that utilise living organisms and molecular biology to produce healthcare innovations. A recent biotech achievement has shown promising applications in cancer treatment.

GENE THERAPY FOR RARE GENETIC DISEASES AND CANCER

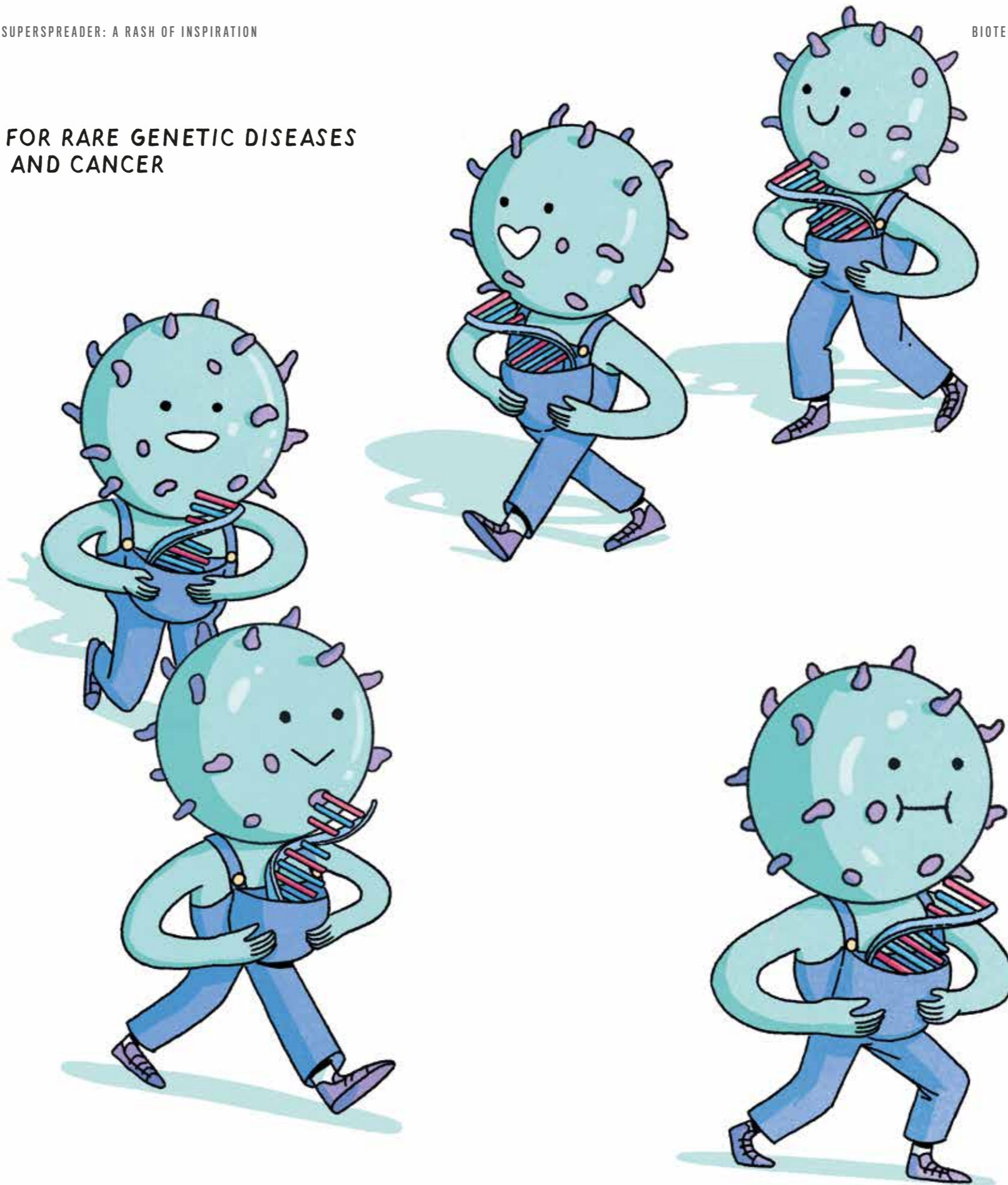
TOGETHER WITH RESEARCHERS from City University of Hong Kong, the research team was able to standardise and validate a platform to purify large-scale amounts of extracellular vesicles (EVs) from human red blood cells. As EVs are natural carriers, they have several advantages over viruses, which are traditionally used as vehicles for therapeutics.

The team next studied how they could engineer EVs for gene therapy. Gene therapy is a treatment that injects genes into patients to fight or prevent diseases instead of using chemical drugs or surgery. The team's research showed that their engineered EVs were able to deliver safely and efficiently therapeutic RNAs to parts of the body that need to be treated. Targeted tissues could then build therapeutic proteins to restore their normal functions.

The innovative technology is now known as the REGENT platform forming the foundation of Carmine Therapeutics, the first gene therapy start-up in Singapore. The start-up clinched a S\$1.2 billion deal with a global pharmaceutical. Carmine Therapeutics is working on applying their biotech to rare genetic diseases and cancer.



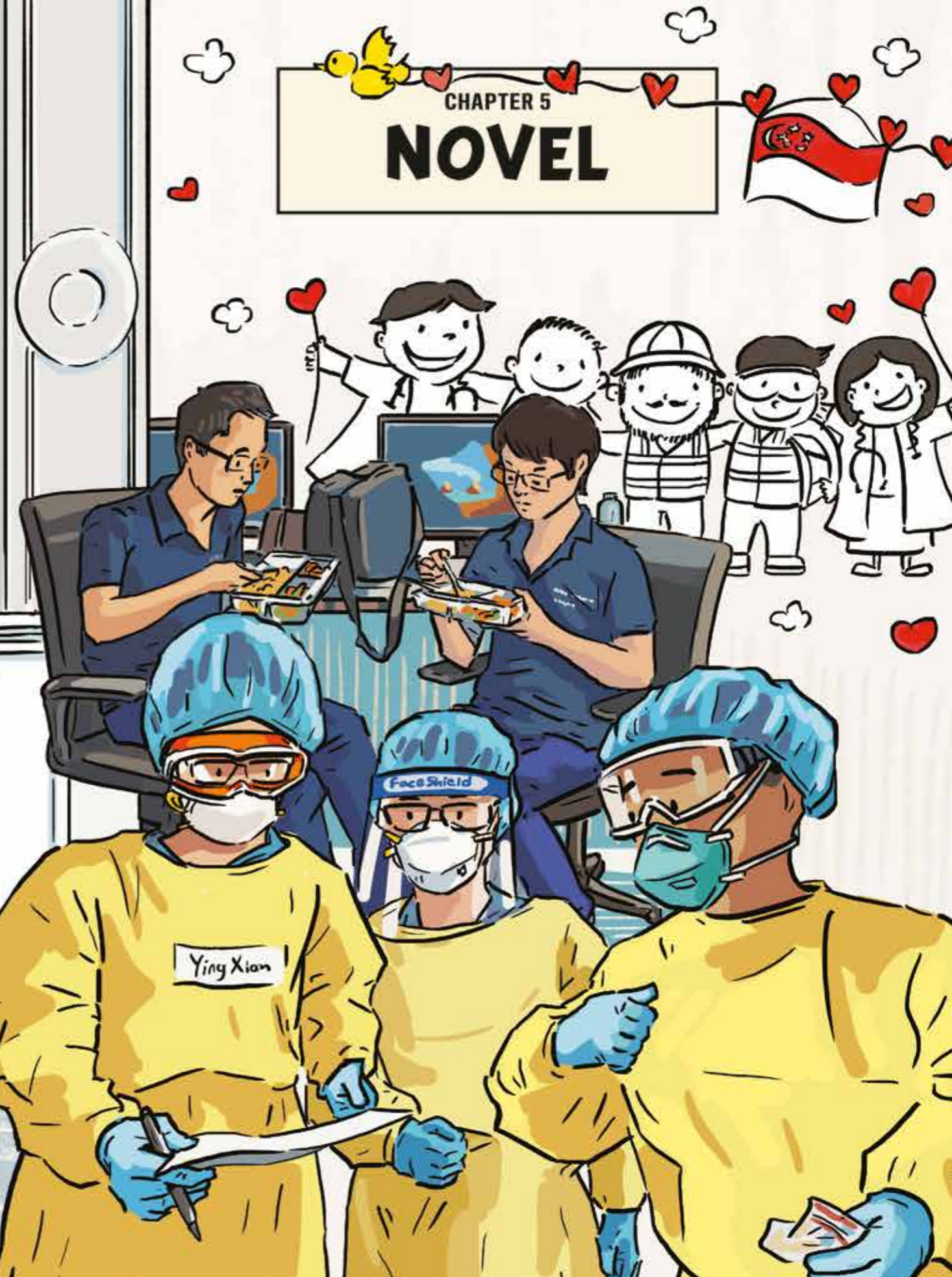
Scan here to read the news article



“Studies have shown that extracellular vesicles (EVs), nanosized particles released by red blood cells, are responsible for intercellular communication. As EVs play the role of natural carriers, several scientists have been trying to use EVs as a drug delivery system. EVs have vast potential as a new therapeutic tool that may revolutionise medical applications.”



Dr Minh Le
Asst Prof, Department
of Pharmacology, NUS
Medicine



CHAPTER 5
NOVEL

NOVEL

THE HEART OF EXPERIENCE

Doctors, nurses, even students taking their first steps in healthcare—all are mobilised in the fight against the pandemic. An educator turns into a frontliner. A clinician shoulders added responsibilities. Undergraduates, marching up to volunteer, find ways to contribute.

Learning on their feet, they assume new roles, remember old ones. Through stresses and strains, fears and uncertainty, they have observed the best of humanity in action and seen the direct impact of their own efforts. They have been inspired while inspiring others.

Our world has changed but we may be stronger for it. It has been a baptism of fire into a new way of life.

CALL OF DUTY: RETURNING TO THE FRONTLINES

At the height of the coronavirus pandemic in April, nursing veteran Assoc Prof Liaw Sok Ying donned scrubs and went back on duty at the National Centre for Infectious Diseases' (NCID) pandemic Intensive Care Unit (ICU).



Assoc Prof Liaw Sok Ying

BEFORE SINGAPORE'S CIRCUIT Breaker began in April, Assoc Prof Liaw volunteered to support nursing services during the coronavirus pandemic.

Her return to clinical practice on secondment was supported by the University and came almost 20 years after she left her job as an ICU nurse at Tan Tock Seng Hospital to take on the role of a Nursing educator.

It was a decision that the registered nurse of 25 years wrestled with. "While my colleagues were battling the pandemic closer to the frontlines, I felt unsettled. Even though I was contributing to the pandemic response by preparing final-year Nursing students to get into the field, I felt that joining the essential workers at the frontline was the right thing to do at that time," she said. She took comfort in her decision to volunteer, knowing she could relieve her fellow nurses of the pressure and strain they were under.

In full swing at the ICU

Faculty members of NUS Nursing were called upon to return to critical care facilities as part of measures to strengthen staffing levels at the ICUs so that they could cope with a surge in patient loads. "Returning to the ICU was challenging for me as critical care nursing is technically demanding and care technology has evolved since I last practised in 2001," said Assoc Prof Liaw, who has been teaching for the past 15 years. To refresh her knowledge and skills, she pored through videos and even brought home manikins from the simulation lab for hands-on training, to refine her skills in procedures such as endotracheal tube suctioning. A crash course and competency assessments organised by the NCID further prepared her for the demanding stint.

At the pandemic ICU, Assoc Prof Liaw began her eight-hour shifts as a registered nurse by buddying with an experienced staff nurse to provide care to severely ill COVID-19 patients. "Some of the cases we took were heavy ones, such as patients on dialysis who needed extracorporeal membrane oxygenation (ECMO)," she said, recalling she was a little overwhelmed by the advanced technology employed at the ICU.

To familiarise herself with the new environment after a long period away from the hospital setting, Assoc Prof Liaw drew up a learning roadmap: she would start small by helping out with basic care tasks such as turning and tube-feeding the patients, and even taking on the role of a "runner", to help fetch items for colleagues who were not able to enter and exit the ICU room freely due to infection control measures. "Due to the uncertainty of the situation, I told myself that I needed to pick things up fast and be ready to handle cases competently and confidently," she said. Gradually, she stepped up to take on cases and perform the role of a charge nurse, providing holistic care for patients.

Embracing psychosocial care:

The essence of nursing

At the pandemic ICU, nursing took on a strong psychosocial focus for Assoc Prof Liaw, as family members could not be there with the patients. She was able to empathise with the patients and their family members, often using music and small talk to diffuse the sense of anxiety in the wards. Chatting with the patients helped her to build rapport with them as well as assess them clinically. She recounted how she upgraded the assessment of a patient from "confused" to "orientated" on the conscious level chart, after learning that he was a scientist and engaging him in conversation about his work. "Through our exchange, I also found him to be very fearful about his condition, so I would constantly update and reassure him about his improving health status based on his vital signs," she shared.

After learning that this patient had rejected video calls with his family out of fear of worrying them about his state of health, Assoc Prof Liaw freshened him up and convinced him to participate in a video call with his family. It was a touching moment for her when she witnessed the family reaffirming their love for one another and making plans to patronise their favourite hawker stall after his recovery. "After the chat, he looked more cheerful," she beamed.

Remembering another call between a mother and daughter that took place on Mother's Day made her tear up behind her goggles. "It was emotional for me, too, as I felt for these patients who had to be away from their families during this time of uncertainty," she recalled.

Taking lessons back to school

"I felt like I experienced training anew, and better understood a nursing student's journey during clinical rotations. When students go into a new setting for the first time, it's important to be humble, to be very hands-on and step up to the task at hand, while learning to work as part of a team," she reflected, adding that the lessons she has learnt would translate to valuable advice for her students.

Having experienced different kinds of coaching styles from the seasoned nurses, she highlighted another lesson for all educators. "Let's be more nurturing, and pass along our wisdom, caring, and confidence to our new and future nurses."

Finally, as a director of education at NUS Nursing, she plans to use her experience to align the educational process with the realities of nursing practice. Her clinical experience has prompted her to reflect on the importance of academic-clinical collaboration to bridge the theory-practice gap and ensure evidence-based practice, with the ultimate goal of improving the quality and relevance of nursing education.



DISPATCH FROM THE FRONT

Alumnus Dr Chua Ying Xian, who graduated in 2010, and Dr Lawrence Lam are family physicians at the National University Polyclinics. They share a glimpse into their work day in what—as least for the immediate future—is the new normal.



Dr Chua Ying Xian



Dr Lawrence Lam



Not your superhero

"This is the fight of our lives. We are going to win. Whatever it takes," said Steve Rogers, better known as Captain America, to the Avengers before they had the exigent yet perilous task of retrieving the Infinity Stones in their bid to reverse a catastrophe. That battle cry was what kept the team going, and can we say the same for the current COVID-19 pandemic?

The outbreak's focus, which shifted from China to Europe by early 2020, had claimed more than 50,000 lives with more than a million infected at this time of writing, with countries shutting off their borders frantically from mid-March in a desperate effort to put a brake on the contagion. Physicians around the world started to share harrowing experiences in various media, from being overwhelmed by the sheer volume of patients streaming into the already overloaded healthcare facilities, to being ostracised by members of the public. People were looking for reliable information, and physician leaders wanted accurate and actionable messages to reach the public.

As a frontline family physician, it has never been more daunting to deliver care for my patients than during this pandemic. Through sweat-soaked clothes and personal protective gear, my team of frontline healthcare providers work tirelessly to differentiate the higher-risk patients from those who have a relatively minor non-COVID-19 infection. From pre-triage screening workflows to appropriate segregation of patients, patients are sent to designated zones for their consults.

Each morning, the team of doctors will huddle for a short discussion, going through countless iterations of revised workflows, updated case definitions and suspect cases' swab results from the day before. About 30% of all clinic attendances are seen by the fever sector during a working week. This will include patients who present with any respiratory symptoms, have declared a significant travel history, and are under stay-home notices or phone surveillance by Ministry of Health officers. This translates to each of us seeing up to eight patients per hour on a busy day. Lunch breaks and

continuing medical education sessions are held in separate zones for fever zone family physicians. Each day ends with a chafed face and an exhausted mind. Photos of healthcare workers unmasked after each shift started circulating on social media, leaving a lasting and palpable image for all.

To top it off, each patient coming through the door poses their own challenge in a pandemic. A low-grade fever and cough might no longer be just an everyday "common cold". Having studied the symptomatology of patients suffering from the novel coronavirus and with five of them passing through our doors earlier on in the outbreak, accurate identification is indeed not a walk in the park. While a large majority of them presented with fever, not all presented with florid respiratory symptoms. Two had initial presentation of lower urinary tract symptoms, and another had clinical and biochemical resemblance to dengue infection, which eventually was diagnosed as a false positive dengue infection.

The work doesn't end when the clinic pulls its shutters down. Each time the phone beeps signifying a new message, I squirm, glancing at the title of the message. Local news with updated workflows is being disseminated at breakneck speed. One hardly has time to fully digest the information before the next update pops up. And before I know it, it's dawn again, and time to head back to the clinic.

Is it what it is?

I still vividly remember the consultation with our first confirmed case. This patient presented to us with six days of a fever and cough developing, having already been seen at the Emergency department. He tested negative for dengue and was discharged. As the clinic where I am practising is surrounded by dengue hotspots, and as his fever was persistent, I repeated his blood count. It was strangely still suspiciously like dengue. In view of the growing numbers of COVID-19 infections, the patient and his wife were naturally worried. As they had no significant travel or sick contact history, we decided to review the patient the next day for reassessment. When he returned, the follow-up blood test showed

worsening platelet counts, which was consistent with dengue fever. But something was amiss when he said, "I am feeling a little more breathless today. Is this part of dengue?"

He had developed an uncommon symptom not quite consistent with dengue. As family physicians, we rely on both our knowledge of outbreak epidemiology along with good history taking and understanding of disease patterns to determine diagnostic probabilities. However, now we were faced with a clinical dilemma as well as conflicting symptoms and laboratory investigations. Dengue fever does not cause cough or shortness of breath usually. Low platelet count was not a common feature of COVID-19 infections either. We knew that we had done what we could in primary care and this patient needed further work-up and investigations.

"Dengue doesn't usually present this way. Let's send you to the hospital for further checks, alright?"

We decided to refer him to the hospital. When we found out the next day about the confirmed COVID-19 diagnosis, we had mixed feelings. Of course, we were worried about getting the infection, along with all our staff and patients who had come into close contact with him. I texted my wife immediately and asked if she wanted to stay with her parents for a fortnight, just to be on the safe side. Numerous messages of concern from family and friends started pouring in. Irrational doubts crossed through my mind the next couple of days. Did I scratch my face after I saw the patient? Was my mask properly fitted? Why is my throat so itchy? Am I...infected?

The fear is real. The concerns are legitimate.

"Please don't come too near me"

It broke my heart when a patient said that and frantically gestured when I was about to examine him. "I think I am infected; I have been staying with a confirmed patient!" exclaimed the young man. "It is OK. I will still examine you. You are under my care. Don't worry, you can see I am wearing my protective gear." My words somewhat reassured him as he sat gingerly at the edge of the chair.

Continued on the next page >>

“Thank you for being kind. Everyone at home is avoiding me like a parasite since I started coughing,” he replied softly. I could sense the sadness in his voice, and on any other day, I would have given him a gentle reassuring pat on his shoulder. That day, I held back. I knew it was the correct thing to do, to minimise physical contact, yet a wave of guilt came over me.

“Hey, I am having a cough and fever”

It is the last thing you want to hear when various staff from different departments come over and report sick. A few did. In full gear, I examined a few of them, before they posed a very difficult question, “Doctor, do you think I might be infected?” These colleagues have been serving and coming into direct contact with the confirmed cases in our clinic. Though most have been attending to the patients in their full protective gear, there’s still this fear that they might be infected. I have the very difficult task of treating them, arranging for swabs to be performed and yet extending words of comfort while asking them to continue to observe the necessary precautionary measures. Through these consults, I tell myself to remain composed and appear fearless, for the battle isn’t just a physical one, but a psychological test as well. The staff need assurance, and I as a team member, must provide them with that.

And we stick together

“What should I do? I just found out my patient was a confirmed case!” On more than one occasion, I have received texts from my private General Practitioner (GP) colleagues. I quickly learnt that it was not fear of acquiring the infection, but the immediate concerns they have for the rest of the patients who are within the vicinity of the confirmed case. Discussions on contact tracing and living apart from family members have become dominant topics, while minimising attending social events has

become the new normal. Yes, the pandemic has forced many to practise social distancing. But it has also afforded opportunities to communicate best practices, share our struggles, and even talk about what’s left of our social life.

As the evening comes

I enter the de-gowning room as the clinic sees the last few patients step out. I disinfect my stethoscope and pulse oximeter and discard the soaked PPE. Peering out of the window, I can see the evening glow in the distance. The familiar faint rumbling of the train and people walking in the distance restore some sense of normalcy. Washing my face, checking the pressure marks on my face and nose, I return to my desk to attend to outstanding emails and work on my lectures, which I am scheduled to give to both post- and undergraduate medical students.

“Part of the journey is the end”

There’s much hype about heroes without capes. I will take a slightly different stand. Superheroes do not fear, we doctors and nurses do. Superheroes do not faint, doctors and nurses do. Superheroes do not weep, doctors and nurses do.

I am not a superhero. I am your primary care doctor. And to my colleagues who stand united and bravely at the frontline—as Tony Stark would put it—part of the journey is the end.

The role of primary care in fighting this pandemic is to triage and identify suspect cases, reassure the public and promote social responsibility to reduce up-trending community transmission. Everyone has a role to play in this fight. We know that this will be a long-drawn war, and we will push on, one patient at a time.

There will be light at the end of the tunnel. But till then, I will be in my gear, ready for the next challenge.

MEDICAL STUDENTS TURNED EMERGENCY WORKERS IN PANDEMIC FIGHT

Banding together, Phase III students Ainsley Ryan Lee Yan Bin, Joelle Tan Hwee Inn and Emma Toh Min Shuen, share their experiences in the fight against COVID-19 as volunteers.



Ainsley Ryan
Lee Yan Bin



Joelle Tan
Hwee Inn



Emma Toh
Min Shuen

WHEN DORSCON ORANGE was first announced in February, we were then-Year 2 students walking into our last afternoon of lectures before our study break. We were too young to remember SARS and new to the healthcare scene. It was a time of uncertainty and apprehension for everyone around us.

This was also a time when the very best of humanity came to the fore. Every so often in the following weeks, we read and saw countless news reports in the media, around the world, and in Singapore, about the selfless sacrifices that healthcare workers were making. These stories got us thinking: inspired and warmed by such dedication, we mulled over how we as medical students could contribute to the fight against COVID-19. We may have a lifetime ahead of us to serve and heal, but we, too, want to do what we can, even as students.

Fortunately, our teachers were most supportive and even offered us the opportunity to establish an attachment supporting the efforts of the Emergency Preparedness and Response Division at the Ministry of Health (MOH).

From April to August, 94 current medical students across all years offered their time and skills in administrative roles to support the multi-ministry helmed task force. Students were spread out across a variety of departments and worked alongside colleagues from various fields, disciplines, and organisations, including the civil service and Singapore Armed Forces (SAF). Many were involved in managing the gargantuan task of coordinating swabs and transportation of persons under quarantine, as well as admissions and discharges for COVID-19-positive individuals. Our students also represented MOH as a liaison to other ministries, where they developed workflows and processes.

Initially, many of us had doubts as taking up this opportunity would mean spending a majority of our time during our holidays working instead of taking a break. However, the camaraderie we experienced during our short stint working with officers from the various ministries left us with an even greater conviction of our purpose.



A fight on many fronts

Apart from our efforts in assisting the multi-ministry helmed Emergency Preparedness, the school saw many students stepping up in other capacities as well. Even before COVID-19 reached Singapore's shores, a team of medical students led by Phase III student Peng Genyi, moved by the brewing crises in Wuhan, worked on a fundraising project, 'Wish Wuhan Well', together with students from the universities across Singapore, to support hospitals at the epicentre in China with medical equipment. What began as a small fundraising initiative amongst students soon saw an outpouring of support, enabling donations of equipment to hospitals across three cities in China.

As we saw the situation evolve in Singapore, we saw the toll on society. Local businesses, especially in F&B, were taking massive hits and our immensely dedicated workers in healthcare, maintenance, and many more were working longer hours, and harder than ever.

This motivated the creation of Project 'In a Heartbeat', named by founding member and Phase III student Rachel Teo. The team set to work collaborating with local F&B businesses to simultaneously support workers on the frontlines. Over the months that followed, deliveries of refreshments and notes of encouragement reached over a thousand healthcare workers in various hospitals, polyclinics, and nursing homes across Singapore. For those who wished to show gratitude and solidarity in ways other than volunteering or donating, we set up a social media platform for them to pen motivational messages. These were printed on origami hearts as notes to go along with the refreshments.

We were immensely heartened that our efforts inspired local F&B businesses to begin their own welfare drives and campaigns as well for healthcare workers!

More than a duty, privilege, and honour

We may have a lifetime ahead of us, serving and giving back to our society, but there is still much we can do for Singapore as medical students. Working

at MOH helped us pick up many new skills that are certainly applicable in our future role as doctors. We learnt how to communicate effectively and clearly in stressful, time-sensitive situations, as well as problem-solving and even some auditing skills.

Initially, the learning curve was very steep as we had to adapt quickly as the COVID-19 situation evolved, and we could not afford to learn slowly. It was imperative to not just keep up, but endeavour to stay ahead at every turn. We had to adjust to learning new terms and acronyms—such as Persons Under Quarantine (PUQs)—and understand the needs and contributions of various ministries like the Ministry of Manpower (MOM), Ministry of National Development (MND), and Ministry of Trade and Industry (MTI). The dynamic nature of the situation meant that Standard Operating Procedure (SOPs) had to be changed every few shifts and we had to adapt to these changes quickly, and discuss ways to adapt our SOPs when we met with unexpected roadblocks. Through the flurry of discussions and difficulties, our colleagues treated us with great respect despite our youth. For the first few shifts, it indeed took some time adapting to the realisation that we were not there as students, but staff members, part of a nationwide team effort.

While working at MOH, there was not much time to think and reflect on the importance and weight of our roles. It felt surreal that the administrative operations we were doing had very real and direct impact on the PUQs and their families we were serving.

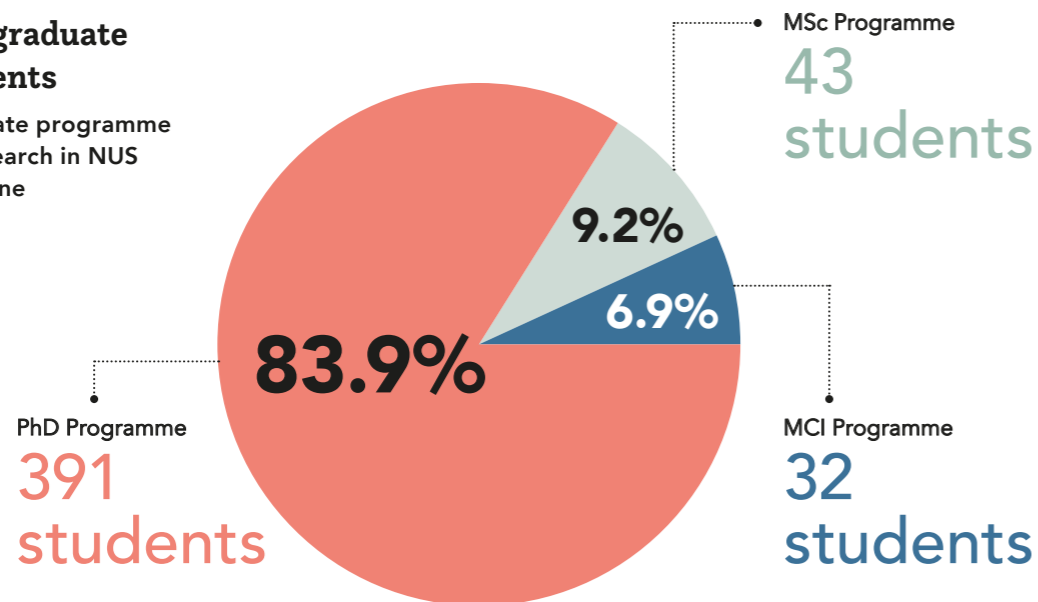
Looking back, we now see how we had been given a rare opportunity to work with a diverse group of people and be part of a nationwide fight worthy of the history books. COVID-19 has brought about changes in Singapore. Moreover, it has brought sectors together and united individuals across the nation. It has been nothing short of an honour to have been part of the fight against COVID-19, a crisis that has given us an even greater conviction to serve as doctors in the future.

STATISTICS, ACHIEVEMENTS, AND ALL ABOUT US

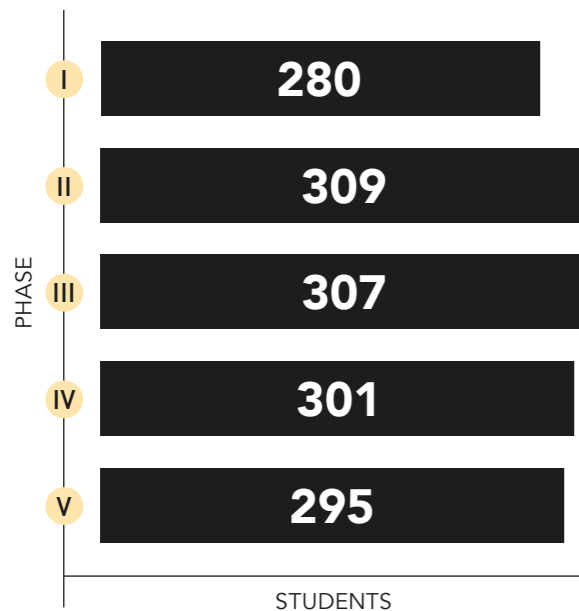
AUGUST 2019 TO JULY 2020

Postgraduate students

Graduate programme by research in NUS Medicine



Undergraduate students



Bursaries awarded

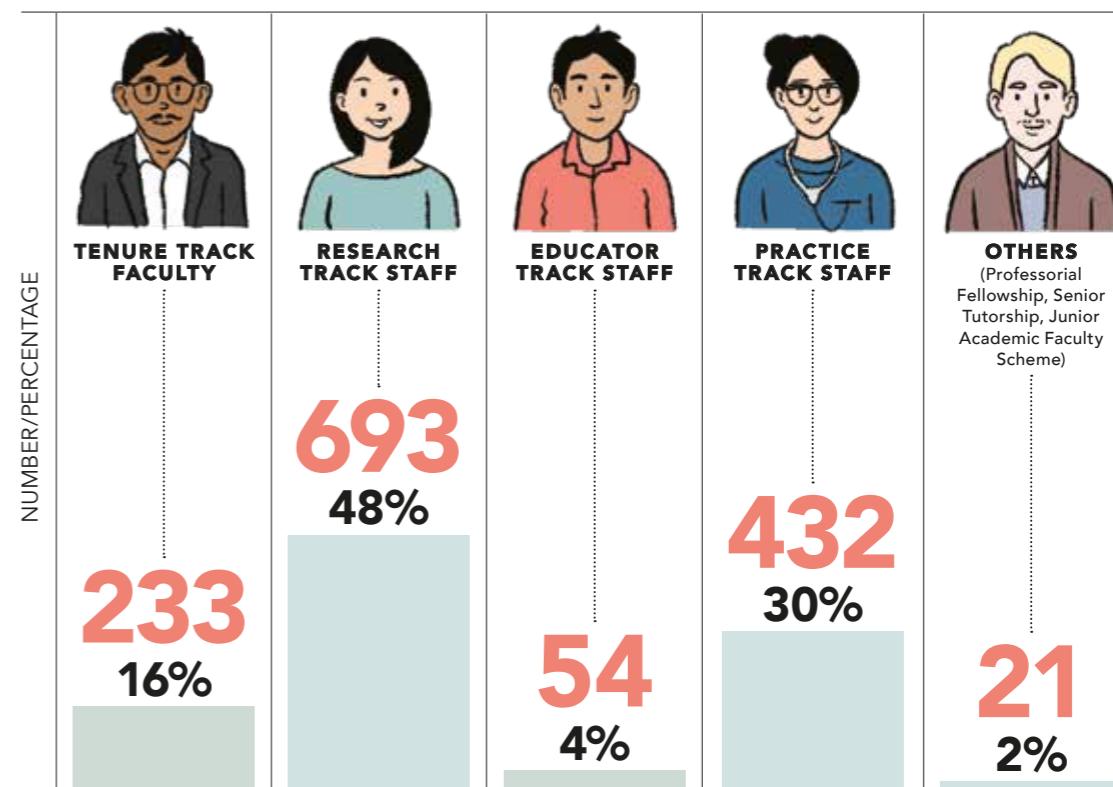
286



Scholarships awarded

73

Type of Faculty (Excluding Adjunct and Visiting)



Papers Published by Academic Faculty

YEAR	2017	2018	2019
Number of papers published	1,446	1,474	1,541
Number of papers with Journal Impact Factor of >10	118	129	161

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OUR HISTORY

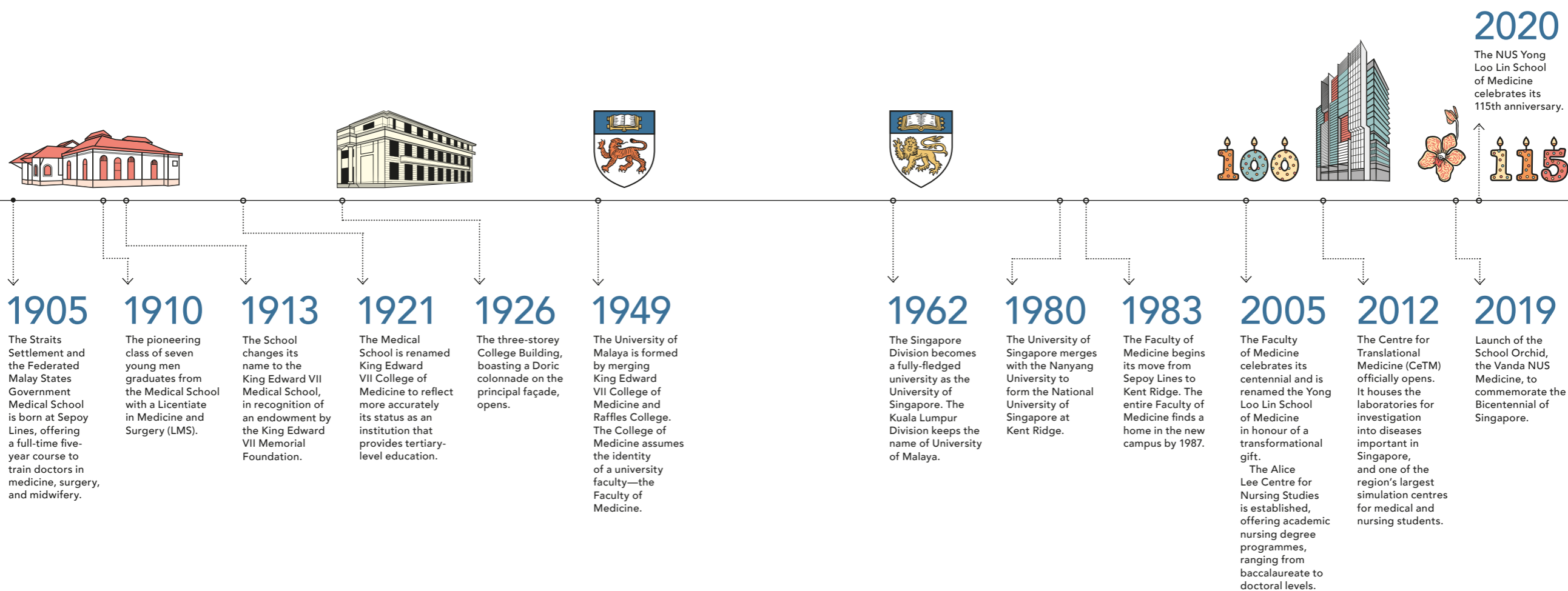
NUS YONG LOO LIN SCHOOL OF MEDICINE'S

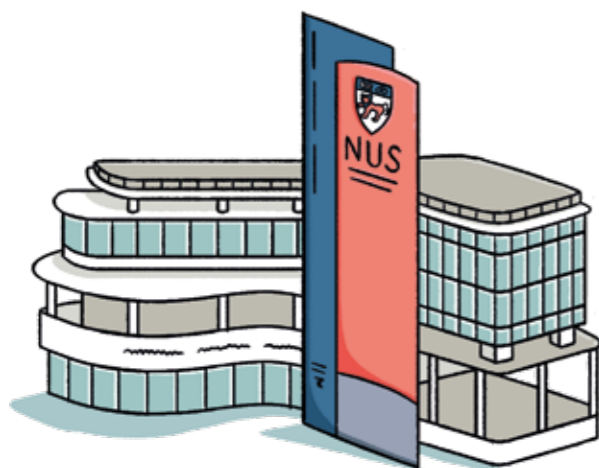
beginnings date back to 1905 when Mr Tan Jiak Kim, a local businessman and philanthropist, raised \$87,000 together with community leaders to establish the Straits Settlements and Federated Malay States Government Medical School. Additional funding amounting to \$13,200 annually was provided by the colonial government for staff salaries, maintenance, and the provision of 10 scholarships. The medical school became the first institution of higher learning in Singapore and was the genesis of NUS.

A female psychiatric hospital at Sepoy Lines (the current location of the Singapore General Hospital at Outram Road) was converted into classrooms and laboratories for the inaugural intake of 23 medical students.

The mission of the School was to produce home-grown doctors trained in Western medicine to serve the local community.

With continued support from donors, the School thrived, expanding from a single building to an entire medical campus. It was to undergo numerous changes, including relocation and name changes.





ABOUT NATIONAL UNIVERSITY OF SINGAPORE

SINGAPORE'S FLAGSHIP UNIVERSITY, the National University of Singapore (NUS), offers a global approach to education, research, and entrepreneurship, with a focus on Asian perspectives and expertise.

NUS has 17 faculties across three campuses in Singapore, and 12 NUS Overseas Colleges around the world. Its vibrant and diverse campus community attracts close to 40,000 students from 100 countries every year.

ABOUT NUS YONG LOO LIN SCHOOL OF MEDICINE

THE NUS YONG LOO LIN SCHOOL OF MEDICINE is Singapore's first and largest medical school. Our enduring mission centres on nurturing highly competent, values-driven, and inspired healthcare professionals to transform the practice of medicine and improve health around the world.

Through a dynamic and future-oriented five-year curriculum that is inter-disciplinary and inter-professional in nature, our students undergo a holistic learning experience that exposes them to multiple facets of healthcare and prepares them to become visionary leaders and compassionate doctors and nurses of tomorrow. Since the School's founding in 1905, more than 12,000 graduates have passed through our doors.

In our pursuit of health for all, our strategic research programmes focus on innovative, cutting-edge biomedical research with collaborators around the world to deliver high impact solutions to benefit human lives.

The School is the oldest institution of higher learning in the National University of Singapore and a founding institutional member of the National University Health System. It is Asia's leading medical school and ranks among the best in the world (Times Higher Education World University Rankings 2021 by subject and the Quacquarelli Symonds (QS) World University Rankings by Subject 2020).



Vision

Inspiring Health for All

Values

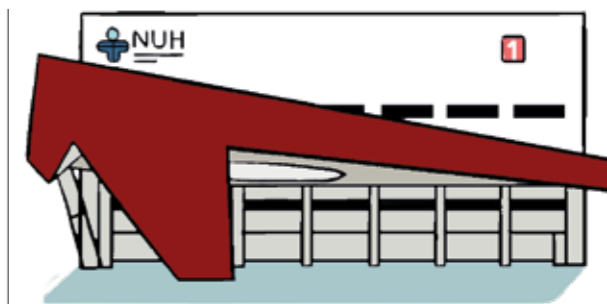
Humility, Compassion, Integrity, Respect

Mission

We nurture the doctors and nurses you would choose to care for your loved ones.

We develop researchers, seek new knowledge and deliver solutions for better health.

We serve with humility, compassion, integrity and respect to improve life for all.



NATIONAL UNIVERSITY HEALTH SYSTEM

THE SCHOOL IS a founding institutional member of the National University Health System (NUHS), an academic health system formed in 2008, dedicated to achieving and maintaining excellence in clinical care, research, and education.

One of three public healthcare clusters in Singapore, NUHS taps on the wealth of resources residing within NUS by drawing upon academic, research, and creative capabilities to develop solutions for existing and emerging health and healthcare needs. It works in close collaboration with community hospitals, general practitioners, family medicine clinics, nursing homes, and other community partners to provide integrated care to the community.

RANKING

NUS MEDICINE IS listed as the leading medical school in Asia by:

- The Times Higher Education World University Rankings 2021 by subject
- Quacquarelli Symonds (QS) World University Rankings by Subject 2020 list



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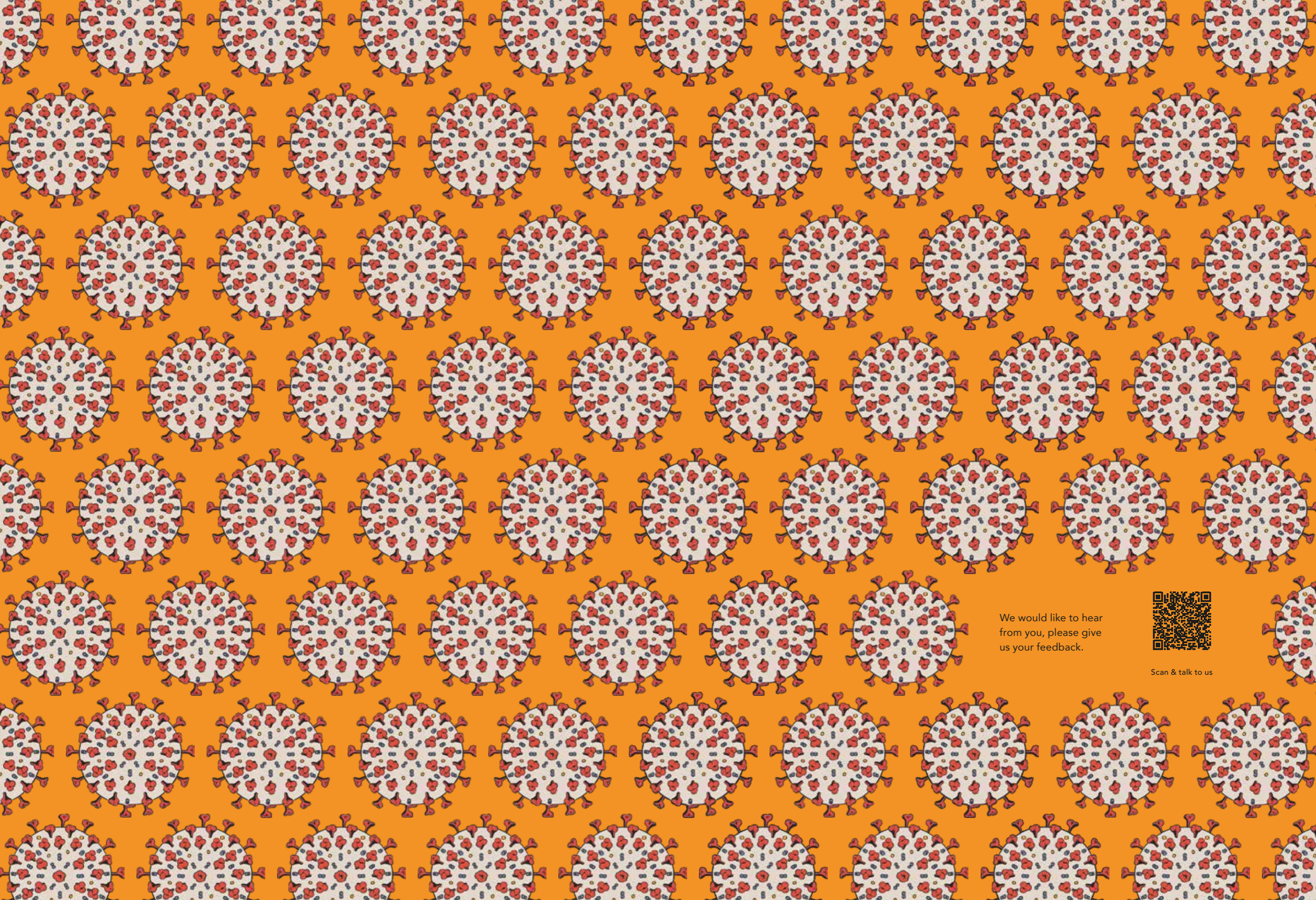
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