

Education

Research

Enterprise

At NUS Science



VISION



To be among the world's best in science education and research

MISSION

To provide quality education, foster the spirit of enterprise and conduct leading-edge research to advance knowledge in Science and Technology for the benefit of Singapore and the global community

FACULTY OF SCIENCE | ANNUAL REPORT 2020

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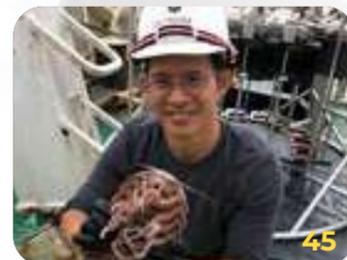
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DEAN'S MESSAGE

The Faculty of Science continues to stay at the forefront of transformative science education and cutting-edge research. As the pandemic situation evolves this year, we also actively address the immediate and long-term challenges, so as to emerge stronger from the outbreak.

Our undergraduate education focuses on opening more pathways for students to acquire breadth and depth of educational training and important soft skills for the workplace. In graduate education, new industry-relevant Masters programmes are developed and offered as a route towards improved career prospects and employability. This year, we also launched over 100 Continuing Education and Training (CET) courses to support NUS' efforts in providing just-in-time education for adult learners.

To further strengthen our leadership in research excellence, we stepped up efforts to recruit top academic talent locally and internationally. Our researchers continue to collaborate with government agencies, industry and academic partners to expand frontier scientific knowledge, and to translate our research to impact lives.

In spite of these challenging times, I am proud to note that our faculty and students pushed ahead with efforts to innovate. Several research teams have progressed towards enhancing research translation and commercialising deep technology startups under the Graduate Research Innovation Programme. Our student teams were also nominated under the NUS Resilience and Growth Innovation Challenge for their thoughtful proposals to address pressing societal issues.

We also seized the opportunity during the COVID-19 crisis to move towards technology-enhanced education. Our early adoption of technology has allowed our educators to embrace the use of digital platforms to facilitate adaptive learning and teaching during the pandemic, and beyond.



“We have not only demonstrated the spirit of excellence amidst the pandemic, but we have leveraged the crisis as an opportunity to continue raising the bar in science education, research and innovation.”

TRANSFORMATIVE EDUCATION

NUS Science's flexible broad-based education enables our students to chart their own learning journeys based on their interests, aptitudes and career aspirations. With a greater focus on interdisciplinary learning, students can look forward to even more pathways across different fields to widen their learning horizons. For instance, they can pair and complete two majors for disciplines with complementary real-world applications, or embark on an interdisciplinary curriculum before delving in-depth into specific fields.

The Faculty graduated the inaugural cohort of students from the Data Science and Analytics undergraduate programme this year. The programme has continued to grow from strength to strength since its inception as it equips students with competencies for a digital world, including the ability to develop novel analytical tools for new scientific applications and industry problems that will emerge in future.

In response to constantly evolving workplace needs, we expanded and diversified our offerings of skills-based, industry-relevant courses for adult learners. We now offer Executive Certificates in Data Analytics, as well as Graduate Certificates and M.Sc. programmes in Industry 4.0, Data Science and Machine Learning, Forensic Science, Food Science and Human Nutrition, and Pharmaceutical Science and Technology.

This year, we provided domain enrichment training to complement the professional development of junior college teachers in environmental chemistry, smart devices and data science. We will also help researchers, scientists and engineers to gain new science and technology capabilities for their jobs through Professional Conversion Programmes.

TRANSFORMATIVE RESEARCH



Since the COVID-19 outbreak began, our scientists have proactively developed innovative ways to fight it across various fronts. Work is ongoing on efforts ranging from diagnostics to case connections, developing portable test kits, modelling the virus transmission, evaluating health promotion initiatives and advising on pest mitigation measures for temporary dormitories and community care facilities.

Other than COVID-19 related research, our faculty members continued to build new capabilities in other fundamental areas. In the area of sustainability sciences, the Centre for Nature-based Climate Solutions was established this year to focus on how nature can be harnessed to address the challenges of climate change. A new partnership is in place to study the impacts of climate change-related extreme weather events on endangered species survival for conservation management.

Our research is closely aligned with national goals. In support of Singapore's 30 by 30 vision to produce 30% of its nutritional needs by 2030, our researchers are developing new capabilities in plant sciences and food production research. For instance, a research team recently discovered the mobile Terminal Flower1 (TFL1) protein as an essential molecular switch for regulating endosperm development and seed size. The biotechnological application of these findings potentially opens up a new avenue to improve crop yield and contribute to food sustainability.

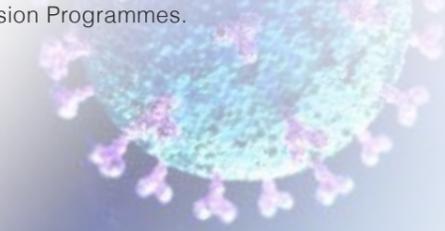
LOOKING AHEAD: 2021 AND BEYOND

Moving ahead, we will further expand our interdisciplinary initiatives and continually integrate and develop more industry-relevant Masters programmes and CET course offerings. Through this, we will nurture lifelong learners and versatile leaders who are digitally adept, skilled in solving multifaceted problems, and ready to succeed in whatever fields their careers may take them to.

We will also pursue more peaks of research excellence in fundamental and translational research, with greater focus on interdisciplinary research that tackles societal challenges. We will scale up our outreach efforts to attract high calibre researchers and graduate students to support us in our quest of impactful science.

I am pleased that the Faculty of Science has not only demonstrated the spirit of excellence amidst the pandemic, but we have leveraged the crisis as an opportunity to continue raising the bar in science education, research and innovation.

Prof SUN Yeneng
Goh Keng Swee Professor of Economics
Dean, Faculty of Science



YEAR IN REVIEW

We affirmed our standing as a faculty at the forefront of transformative science education and cutting-edge research. The year's milestones include the establishment of the Centre for Nature-based Climate Solutions, expansion of our Continuing Education and Training (CET) offerings, new academic collaborations and several inaugural events.

NEW ACADEMIC PROGRAMMES

▀ B.Pharm. (Hons)

The four-year flagship Pharmacy degree has been renamed as B.Pharm. (Hons), with a transformed interdisciplinary curriculum that fully integrates basic, clinical and systems sciences. Pharmacy graduates will be trained as care providers who are adept in navigating the fast-changing healthcare landscape, in the age of technology and informatics. The programme admitted its first cohort in Academic Year 2020/2021. Its active approach to learning and teaching, ranging from online team-based learning to case inquiry, is unique in Southeast Asia (pg 39).



▀ Minor in Bioinformatics

The multidisciplinary minor programme will be launched in Academic Year 2021/2022 for all current and incoming cohorts. It will provide broad coverage of the theory and applications of bioinformatics, as well as programming skills and practice in applying them. The programme will support the growing demand for bioinformatics expertise in biology and medicine (pg 31).



PIONEER COHORT OF GRADUATES

This year marked the graduation of our inaugural cohort of Data Science and Analytics students. The four-year Direct Honours programme equips students with the ability to develop novel analytical tools for new scientific applications and industry problems of the future. Our graduates are therefore well-placed for careers in diverse industries requiring extensive data collection, processing and analysis (pg 43).



NEW ACADEMIC COLLABORATIONS



Image credit: UON, Australia

The Faculty collaborates with reputable universities to develop study abroad programmes which provide students a global learning experience. We established a six-year Student Exchange Programme with The University of Newcastle (UON), Australia from 1 September 2019. Our undergraduate students can read courses from various specialties across established and emerging science disciplines in UON.



Image credit: OUC

The Food Science and Technology Department and NUS (Suzhou) Research Institute (NUSRI) signed a 3+1+1 Joint Educational Programme Agreement with Ocean University of China (OUC), College of Food Science and Engineering. Under the five-year agreement from 25 March, Year 3 OUC students will spend their fourth year at NUSRI before applying for our M.Sc. in Food Science and Human Nutrition programme (pgs 16 and 35).

CONTINUING EDUCATION AND TRAINING



OVER 100 COURSES THIS YEAR

RESEARCH

▀ Centre for Nature-based Climate Solutions



Leading conservation scientist Prof KOH Lian Pin joined NUS in April, where he helms the newly established Centre for Nature-based Climate Solutions. The Centre will produce policy-relevant science to address knowledge gaps, build capacity and deliver pragmatic solutions and innovations to inform climate policies, strategies and actions in Singapore and the Asia Pacific.

The Centre is jointly supported by NUS and the National Research Foundation. In addition, MAC3 Impact Philanthropies has made a generous \$1.1 million gift to NUS in support of the Centre. This will fund innovative and interdisciplinary research, with a focus on oceans, marine and coastal ecosystems.

We expanded our offerings of skills-based, industry-relevant courses to support lifelong learning and workforce resilience for our graduates and other adult learners. We now offer Executive Certificates in Data Analytics, as well as Graduate Certificates and M.Sc. programmes in Industry 4.0, Data Science and Machine Learning, Forensic Science, Food Science and Human Nutrition, and Pharmaceutical Science and Technology (pgs 15 and 16).

This year, we also offered domain enrichment training to complement the professional development of junior college teachers in environmental chemistry, smart devices and data science.



AT NUS SCIENCE

KEY
EVENTS

Temasek Foundation-NUS STEM
for University Educators Programme in ASEAN

Over 120 university educators, high school teachers and private educational organisations representing more than 30 institutions in Vietnam attended an inaugural science communications and STEM (Science, Technology, Engineering and Mathematics) workshop at the Vietnam National University-Hanoi University of Science on 7 to 9 November 2019. This was the first time the Faculty partnered with an ASEAN university on the workshops. Plenary speakers and facilitators shared on developments in STEM education, strategies to raise interest in STEM and practical classroom pedagogy.



NUS-Grandes Écoles French Double Degree
Programme 20th anniversary

The programme celebrated its 20th anniversary on 11 November 2019 with a joint forum by NUS and its partner Grandes Écoles. Guest-of-Honour His Excellency Mr Marc ABENSOUR, Ambassador of France to Singapore, NUS President Prof TAN Eng Chye and Mr Eric LABAYE, President of École Polytechnique, delivered speeches on the changing landscape of higher education in Singapore and France respectively. This programme is offered exclusively at NUS and is the longest running academic collaboration between France and Singapore.



Inaugural Ph.D. eOpen Day

The Faculty participated in the first NUS Ph.D. eOpen Day on 29 October. We hosted a virtual booth where participants could find out more about our Ph.D. programmes and engage in live chats with faculty members.

Prof ZHAO Yu, the Faculty's Assistant Dean of Graduate Programmes, was a panellist in the forum. Prof RONG Li (Biological Sciences), Prof Guillermo C. BAZAN (Chemistry), Prof Christina CHAI and Prof Matthias G. WACKER (Pharmacy), and Dr LI Qianxiao (Mathematics) gave talks.



Inaugural Data Science Industry Fair

Over 300 students from different faculties, with guidance from industry mentors, battled it out to develop Artificial Intelligence (AI)-driven applications (apps) that could predict outbreaks of dengue at the Internet-of-Things (IoT) Datathon 3.0 in December 2019. The Datathon culminated in a grand finals competition on 17 January, and was held in conjunction with our inaugural Fair. The fair brought together 10 employers to share on career opportunities in AI and data science.



Online industry seminars

The Faculty organised a series of online industry seminars for our students from June this year. Guest speakers from our industry partners share on industry trends and outlook, career opportunities, job functions and employer recruitment expectations. Our students also gain insights to prepare for the changing job market.



OUR ALUMNI
IN PARLIAMENT

Following Singapore's General Election 2020, two of our alumni, Mr **Louis NG** (Biology* 2002) (right) and Mr **GAN Thiam Poh** (Mathematics and Economics 1988) (left), were elected as Members of Parliament (MPs) in Nee Soon GRC (Group Representation Constituency) and Ang Mo Kio GRC, respectively. MPs play a crucial role in bridging their communities with the government, helping to implement government policies and programmes, and performing legislative roles.

* Now Life Sciences



NEW
FACILITIES

Wet Science Building (S9)

The Faculty will occupy five floors of S9 by end 2020, supporting more than 25 research groups working on green chemistry, materials chemistry, pharmacy and biochemistry. S9 will also house other key NUS research initiatives and student interaction spaces. S9 was designed for safety and sustainability, and it is the first research laboratory building in Singapore to achieve the Building and Construction Authority's Green Mark Platinum certification.



PitStop@Science

The Faculty, NUS' Office of Student Affairs and the NUS Students' Science Club revamped one of two student lounges as a multipurpose space for Science students to mingle and relax. A projector, board games, an arcade machine and two Nintendo switch sets with televisions were set up for recreation. The students also dressed up the area with inspirational decals.





EDUCATION BRINGING SCIENCE TO YOUTHS

The Faculty and our partners run pre-undergraduate research programmes, competitions, workshops, school visits, talks and the Faculty Open House to promote interest in science and encourage students to read science at NUS. COVID-19 restrictions did not deter us from continuing our outreach to prospective students, through various novel online initiatives.

PHYSICS E-LECTURE SERIES

Since May, the Department of Physics has rolled out a series of e-lectures to engage students in exciting science topics, including string theory, quantum physics and nanomaterials. Interactive live demonstrations enable viewers to visualise and better understand scientific concepts. Each session draws about 100 to 200 students. There are plans for more e-lectures in the future (pg 42).

SOME 600 ATTENDEES

SCIENCE RESEARCH PROGRAMME (SRP)

The SRP culminated in the first-ever virtual Science Research Congress on 29 April, drawing budding scientists who got to work alongside scientists on STEM (Science, Technology, Engineering and Mathematics) research. The video conference showcased selected research findings of 88 students from 13 junior colleges and Integrated Programme schools. 14 projects clinched 1 Gold, 3 Silver, 1 Bronze, 6 Merit and 3 Special Awards at the Singapore Science and Engineering Fair (2020) in May.

88 STUDENTS COMPLETED SRP THIS PAST YEAR

DEPARTMENT E-ENGAGEMENT EVENTS

OVER 1,000 PROSPECTIVE STUDENTS



The Departments of Biological Sciences, Chemistry, Food Science and Technology, Mathematics, Pharmacy, Physics, and Statistics and Applied Probability, as well as the Data Science and Analytics, Environmental Studies and Pharmaceutical Science programmes, hosted a series of virtual engagement events from 15 to 24 April to encourage prospective students who received admission offers to study science at NUS. The customised programmes provided information on our courses, learning opportunities and the career prospects of science graduates through virtual talks, tours, students and alumni sharing, and displays of our experiments and technology. The Special Programme in Science was also showcased online for the first time.

FACULTY E-OPEN HOUSE

OVER 1,000 ATTENDEES



Our inaugural e-event on 16 May comprised programme talks and live chats with faculty members on NUS Science education and student life. This edition also featured several new online initiatives. These included a Surprising Science! series of 16 videos where our award-winning professors each explained a scientific concept or the application of a theory in a simple but intriguing way. There was also sharing by student leaders on e-orientation activities and a virtual faculty tour video.

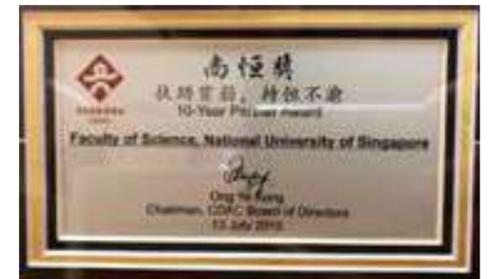
SCIENCE E-TALKS TO SCHOOLS



As part of our outreach programme to pre-university and polytechnic students, the Faculty conducted virtual talks for local high schools such as Dunman High School, Hwa Chong Institution, St Joseph's Institution (SJI) and SJI International. We also extended video guides on our programmes to NUS High School of Mathematics and Science, and Anderson Serangoon Junior College (JC), and conducted interactive sessions for various local JCs, institutes and International Baccalaureate schools. Through these sessions, students were introduced to the diverse learning opportunities here, such as our multidisciplinary and cross-faculty programmes, undergraduate research programmes, internships, student exchange programmes etc., as well as the career prospects of science graduates.

CHINESE DEVELOPMENT ASSISTANCE COUNCIL (CDAC) AWARD

The Science Demonstration Laboratory (SDL) and Young Educators in Science (YES) have been working with the CDAC to cultivate interest in STEM (Science, Technology, Engineering and Mathematics) amongst more than 1,000 underprivileged students through workshops, coaching and project work. In July, the Faculty received CDAC's 10-year partner award for our decade-long contributions to this effort.



SCI@HOME INITIATIVE

To help children from low-income families whose access to learning opportunities was adversely impacted by COVID-19, SDL and YES produced affordable experiment kits to bring science into their homes. Each kit contains an activity booklet for meaningful science-based enquiry. Complementary online workshops are held for volunteers and beneficiaries. Our prospective partners include volunteer-led organisation Cahaya Community, CDAC and People's Association Youth Movement. This project is funded by NUS' Resilience and Growth Initiative and will be ongoing into 2021.



SDL also developed kits on electromagnetics, optics and solid state physics experiments for Physics undergraduates, which were delivered by post to students. Students conduct the experiments at home and are provided full online guidance (pg 24).

DESIGN-YOUR-OWN-MODULE (DYOM)

YES launched its first DYOM in January, where SDL staff guided incoming YES members on practical science communication and content development in mathematics and science outreach. The course also hosted talks by science communication specialists from industry and Science Centre Singapore. 23 students from multiple disciplines enrolled for the course, which emphasises practice, peer review and expert feedback, as well as collaboration and introspection.



EDUCATION

GROOMING FUTURE-READY GRADUATES

The Faculty continually enhances our suite of academic programmes to provide students the breadth and depth of educational training and critical soft skills for the fast-changing workplace.

FLEXIBLE CURRICULUM

NUS Science's flexible broad-based education enables our students to chart their own learning journeys based on their interests and career aspirations. With greater focus on interdisciplinarity, students can look forward to even more learning pathways.



"The Singapore Police Force (SPF) requires us to analyse information from various sources, like witness statements and CCTV recordings, to piece together a coherent story that leads to the truth. Psychology enables us to understand how a myriad of behaviours can drive criminality."

Year 4 student LEE Kai Yang is reading a **Double Major in Life Sciences and Psychology**. He will be joining the SPF.



"My interest is in building novel models to generate insights on infectious diseases that guide policy-making. My economics training adds the dimension of better resource allocation to the insights."

CHENG Yuwei, a fresh **Double Degree Programme** graduate in **Statistics and Economics**, is a Research Assistant at the NUS Saw Swee Hock School of Public Health. Yuwei works on COVID-19 modelling projects and vaccine impact evaluation for Japanese encephalitis.



"Exposure to the interconnectivity between different disciplines broadens my academic horizons."

Antony HARTANTO, Physics Year 3, was accepted into the **Special Programme in Science**, a multidisciplinary programme that teaches scientific, computational and communication skills through multidisciplinary research, peer learning and mentorship.



"These courses appear as seemingly contrasting majors, but I see them as complementary. Environmental sustainability, misinformation and digital divides are issues close to my heart. I hope to integrate these skills to become a science communicator who bridges the knowledge gap between experts and the public."

Year 4 student CHUA Wee Han is reading a **Double Major in Life Sciences and Communications and New Media**, with **Minors in Geosciences and Aquatic Ecology**.



"This module opened my eyes to the ingenious uses of mathematical concepts in architecture."

Nicholas FOO, Mathematics Year 3, took up the Mathematics and Architecture **Design-Your-Own-Module (DYOM)**, where he gained a fresh perspective of mathematical applications in ancient and modern architectural designs.

DYOM encourages students to learn beyond their disciplines, without disrupting their structured studies.

EXPERIENTIAL LEARNING

Global education

Our suite of Study Abroad Programmes opens the door to a global learning experience, exposing students to different cultures and academic environments. This broadens their intellectual and global outlook.



"The wide curriculum, interesting modules and hands-on activities at onsite facilities such as a dairy plant and winery, added depth and breadth to my understanding of food science. I also gained insights into other education systems and teaching pedagogies in the global context."

YEAM Cheng Wee, a Year 4 Food Science and Technology student, found his **Student Exchange Programme (SEP)** at Cornell University (College of Agriculture and Life Sciences) an enriching experience.



"I was encouraged to cross-apply knowledge from various disciplines to form the bigger picture. Through this, I learnt to better appreciate the interconnectedness of natural systems in biology and geography, and the practical applications of environmental concepts in real-world examples."

Keith SNG, Environmental Studies Year 4, opted for the **SEP** at liberal arts school Colgate University, where students read courses from various fields of inquiry before choosing to specialise.



"I witnessed how Traditional Chinese Medicine (TCM) practices come alive, from touring herbal gardens and understanding the hidden medicinal properties of various plant species, to visiting manufacturing plants and hospital pharmacies. I was amazed at how TCM advancements complement Western medicine."

Alicia GOH, Pharmacy Year 3, explored Taiwan's diverse socio-cultural-economic environment under the **NUS Study Trips for Engagement and EnRichment (STEER)** programme.

Entrepreneurship education

Aspiring entrepreneurs can participate in unique and immersive programmes at startup companies and attend related courses at partner universities.

"With assistive technology like Virtual Reality, we can participate actively in storytelling and co-creating the narrative in the near future."

WANG Heqiao, Data Science and Analytics (Minor in Language Studies) Year 3, interned at local startup video entertainment platform Viddsee (Singapore) under the **NUS Overseas Colleges (NOC) Singapore** programme to gain industry experience as an entrepreneur in the entertainment industry.

At Viddsee, she participated in Juree, its annual filmmaker event, and conducted research into China's video streaming subscription market as well as market forecasts on its YouTube channel views.

Internship

Putting learning into action beyond the classroom is an integral part of our student experience. This enables them to gain real-life work exposure.

"I gained meaningful work experience in helping to address pandemic-related challenges."

Nafeesah IBRAHIM, Chemistry Year 4, extracted data from modelling reports and drafted policy briefs projecting COVID-19 outbreaks in different countries under the **Undergraduate Professional Internship Programme (UPIP)** at the NUS Saw Swee Hock School of Public Health.

She conducted data collation and analysis on diverse workforces in global health organisations for policy implementation.





EDUCATION LEARNING FOR LIFE

We encourage our graduates to upskill and reskill through executive and professional courses, to help them stay relevant at the workplace. Some of our graduates embark on postgraduate studies, contributing to the further advancement of science.

M.SC. IN FORENSIC SCIENCE

Life Sciences alumnus Mr **Taylor ONG** is participating in the inaugural run of the new M.Sc. in Forensic Science programme. This programme synergises science and law to nurture forensic science practitioners (pg 31).

Taylor said, "The course provides insights into forensic science techniques and technologies for advancing the administration of justice. My professors and course mates bring diverse, often unique, perspectives. This prompts us to broaden our views."



M.SC. IN INDUSTRY 4.0 (I4.0)

Life Sciences alumnus Mr **TAN Yan Ming**, a researcher in bioinformatics/biostatistics at the Faculty's Department of Statistics and Applied Probability, recently graduated from the inaugural run of the M.Sc. I4.0 programme. This programme equipped him with technical knowledge and real-world Machine Learning experience. This opens doors to technology-related careers in other sectors or to pursue a Ph.D. in an area of interest, such as computational biology. This multidisciplinary programme prepares graduates to keep pace with the changing nature of industries amid technological disruptions.

Yan Ming said, "It was an invaluable opportunity to acquire skills in advanced technologies that impact every aspect of business and our lives. With the growing demand for data science expertise, even within the realm of biological sciences, this is a timely and critical skillset."



M.SC. IN DATA SCIENCE AND MACHINE LEARNING

Mathematics alumnus Mr **Danny TEO**, from the programme's inaugural cohort, wanted to upgrade his data science and Machine Learning (DSML) skills to boost his career development. This programme develops manpower to support the high demand for DSML professionals in Singapore (pg 37).

Danny said, "The knowledge I gained on the concepts and methodologies in data science and Machine Learning is highly applicable as more companies turn to insights from Big Data. I hope that this knowledge can also open up new business opportunities."



M.SC. IN FOOD SCIENCE AND HUMAN NUTRITION

Mr **LIM Meng Thiam**, a dietician and currently a senior scientist at a multinational healthcare company, was working for many years before he decided to pursue this programme full-time. This programme better prepares graduates for the rapidly changing food industry (pgs 8 and 35).

Meng Thiam said, "The SkillsFuture Singapore (SSG) grant gave me peace of mind to focus on my studies in advanced topics like food bioscience. The knowledge I have gained is highly relevant to my work."



M.SC. IN PHARMACEUTICAL SCIENCE AND TECHNOLOGY

Ms **CHONG Suet Yen**, a Research Assistant at the Department of Surgery, NUS Yong Loo Lin School of Medicine, decided to stack up her Graduate Certificate in Pharmaceutical Process and Technology to read the M.Sc. programme. This programme trains qualified personnel for the biopharmaceutical industry (pg 39).

Suet Yen said, "The specialised industry knowledge allows me to pursue my interest in the science of drug development and pharmaceutical regulations. The SSG-subsidised modules reduced my financial burden."

GRADUATE CERTIFICATES IN - DATA MINING AND INTERPRETATION - DEEP LEARNING FOR INDUSTRY

Mr **YANG Jinluo**, who plans to pursue a career as a data analyst or algorithm engineer, took up these Graduate Certificate (GC) programmes to deepen his knowledge in data manipulation. These GC programmes provide students knowledge in Machine Learning applications in data analytics, which are critical in solving Big Data problems in industry.

Jinluo said, "I hope to apply expertise in Artificial Intelligence to help solve complex problems and drive business outcomes such as process automation."

Jinluo hails from China and has degrees in engineering and finance.



ADVANCING SCIENCE THROUGH RESEARCH

Dr **TAN Yaw Sing**, Senior Research Scientist at the Bioinformatics Institute, Agency for Science, Technology and Research (A*STAR), believes that continuing his learning beyond his undergraduate degree has added value to his current work in computer-aided drug design. After graduating from NUS with Double Majors in Chemistry and Life Sciences, he went on to pursue his Ph.D. at the University of Cambridge.

Dr Tan said, "The learning experience was invaluable. I had the privilege of working on drug discovery projects with luminary scientists and gained insights that help shape my scientific thinking."

RESEARCH

LEADING TRANSLATIONAL RESEARCH

The Faculty conducts research to advance knowledge, industry and society. Our researchers continue to win competitive public sector grants and collaborate through high-impact partnerships with universities worldwide, government agencies and industry, to translate scientific innovations into solutions for real-world problems.

UNDERSTANDING THE FACTORS ASSOCIATED WITH SKIN AGEING

The Functional Genomics research group led by Prof **CHEW Fook Tim**, Department of Biological Sciences, partnered leading consumer goods company Procter & Gamble to evaluate the underlying factors associated with skin ageing in Asians, such as the role of modern lifestyle factors and their interactions with skin properties. This research will help companies develop better products for Asian consumers (pg 32).

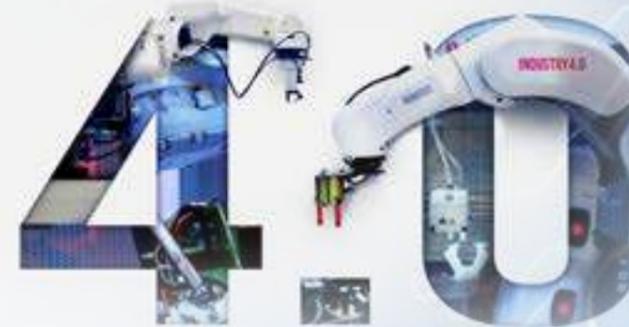


UNDERSTANDING THREATS TO THE SINGAPORE FRESHWATER CRAB

The Freshwater and Invasion Biology research group led by Prof **Darren YEO** with Ms **Elysia TOH**, Department of Biological Sciences, is partnering the National Parks Board to study the impacts of climate change-related extreme weather events and stream acidification on the survival of the Singapore freshwater crab (*Johora singaporensis*). This is among the 100 most threatened species on the planet. The research is supported by the Wildlife Reserves Singapore Conservation Fund, and will help inform conservation management of this critically endangered species.



DEVELOPING ARTIFICIAL INTELLIGENCE (AI)-POWERED FORECASTING



The Data Science research team led by Prof **CHEN Ying**, Department of Mathematics and Risk Management Institute, is working with United Parcel Service Pte Ltd to develop customised forecasting models for improved freight delivery. Industry 4.0 has spurred businesses across the globe to digitise, and heightened the development and application of “smart” algorithms to understand Big Data in the freight industry. This enables smarter and more effective forecasting decisions.



COMMUNITY STEPPING UP IN A CRISIS

Many unsung heroes from our Science community have shown great generosity of spirit during COVID-19. They have gone beyond the call of duty to provide help and support, from taking care of migrant workers to joining frontline efforts, and supporting our workforce with skills and jobs.

OUR STAFF

"We were happy to be able to help foreign workers meaningfully through education."

As Master, Kent Ridge Hall, Mathematics' Dr **NG Kah Loon** and his team produced a video series on financial literacy for recovering migrant workers housed at Prince George's Park Residences, a designated Quarantine Facility. Through these 'classes', the workers acquired useful financial planning knowledge and skills.

"I was glad to play a part in reaching out to rental households that had difficulties coping."

As a grassroots leader in the People's Association Youth Network in Boon Lay, Scientific Officer Ms **CHEE Min Yee** volunteered to work with community centres and residents' committees to distribute surgical masks to residents. She also educated them on proper mask usage to promote socially responsible behaviour.



OUR STUDENTS

"It was physically draining, but it was fulfilling to contribute to the national effort by helping to detect cases early."

Chloe KOH, Pharmacy Year 2, volunteered with the Health Promotion Board from June to August as a swabbing assistant at Community Recovery facilities. She took biological samples from foreign workers in dormitories and other quarantine facilities in Singapore. She was deployed to different sites daily, where the swab count ranged from 50 up to 1,000 clients.



"I hope that we can contribute to create a more inclusive society for migrant workers."

During COVID-19, the Project We Are One (WAO) team, led by founder **Jaymond TAN**, a fresh Applied Mathematics graduate, assembled weekly care packs in five languages. The packs contained updates on the pandemic, exercises and "Word of the Day" for migrant workers. They also created YouTube videos and weekly TikTok videos to raise awareness about migrant workers.

WAO is an NUS Students' Community Service Club outreach initiative to foreign workers.



OUR ALUMNI

"We adapted our tag-to-tag tracing technology for maternity hospitals, to help hospitals fight COVID-19."

Cadi Scientific Pte Ltd, founded by Mathematics and Physics alumnus Dr **Zenton GOH**, is a leading provider of real-time location- and contact-tracing solutions for hospitals in Singapore. Its technologies, incorporated in wearable tags for patients, visitors and staff, help in contact tracing. In addition, its new hand hygiene compliance system utilises wearables that remind healthcare providers to wash their hands regularly, to minimise cross infection.

Cadi Scientific is a healthcare technology solutions company.



"This novel method reduces the complexity of devices used for the detection of pathogens and contributes towards accurate and early detection, enabling appropriate care for patients."

Life Sciences alumnus Mr **Muhammad Nadjad bin ABDUL RAHIM** is part of the team at NanoBio Lab, Agency for Science, Technology and Research (A*STAR) that developed a new method for extremely rapid amplification of nucleic acids that enables detection of COVID-19 within five minutes. The breakthrough method can multiply the genetic material of the virus in patient samples exponentially at a single temperature.



"Candidates work on some of the most complex technical problems on quantum hardware development that would be deployed on board satellites."

With jobs slashed in the pandemic, Physics alumnus Mr **LUM Chune Yang**, Co-Founder of SpeQtral, offered paid traineeships under the SGInnovate Summation Programme to help current undergraduates and the graduating cohort of 2020 gain industry-related skills and boost their employability in preparation for eventual economic recovery.

SpeQtral is a quantum technologies startup.



"Some ideas about how the virus attacks the body and how the immune system responds can be complex for children. We made use of animations and analogies to explain such concepts."

Life Sciences alumna Ms **TAY Wee Beng**, a Senior Curriculum Specialist (Biology) at the Ministry of Education is part of the team that developed COVID-19 learning packages to educate students on the virus. With this knowledge, students can play an active role to take care of themselves and their families.





COMMUNITY

CELEBRATING STUDENT ACHIEVEMENTS

Our students achieve excellence beyond the classroom in areas ranging from sports to community service. They contribute in meaningful ways to the NUS community and society at large.

ALL-ROUND EXCELLENCE

LIM Jie Chong, fresh Pharmacy graduate, received the NUSS Medal for Outstanding Achievements (2020) in recognition of academic excellence and his extra-curricular contributions. As a Community Health Angels Monitoring Programme leader, he visited the elderly to manage their medication-related issues. He was part of a medical mission to Cambodia that provided workshops and pharmaceutical care at local clinics. He also contributes to the City Chinese Orchestra as an experienced suona player.



GENERATION GRIT

Coping with progressive idiopathic scoliosis since youth taught fresh graduate **Grace CHENG** to always seize the day. She is an active volunteer. She taught dance classes in Raffles Hall and supervised co-curricular activities including Raffles Volunteer Corps and nature conservation group Green Committee. In June 2019, she underwent spinal fusion surgery to realign her spine, and undauntedly went on to win the Forensic Expert Witness Advocacy Competition (2020). Grace majored in Life Sciences with a Minor in Forensic Science.



Vera SIM, Environmental Studies Year 2, battled obsessive compulsive disorder (OCD) and emerged stronger. She used to obsess over her handwriting, but with therapy and support, she has learnt to accept and manage her OCD and not to allow it to dominate her life. With strengthened mental resilience, Vera is now ready to push ahead to fulfil her dream of working in the biodiversity field.



BUDDING SCIENTISTS

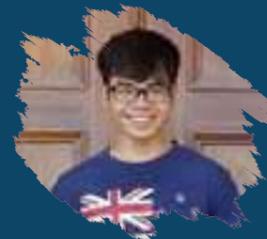
Four students received the Outstanding Undergraduate Researcher Prize (2020), which recognises the best undergraduate researchers in NUS.



Chemistry's **LIM Li Jun** (Double Major in Pure Mathematics) showed the realisation of green emitting Indium arsenide-based colloidal quantum dots with good photoluminescence, which could be applied in next generation display technologies.



Life Sciences' **ONG Shujian** (Minor in Engineering Materials) developed an edible meat-like scaffold for cell-based cultured meat and co-founded startup Ants Innovate to develop platform technologies for an animal-free meat production system.



Applied Mathematics' **TAN Wee Ling** (Minor in Economics) studied malicious software detection using deep learning models and how data augmentation based on Generative Adversarial Networks allows for performance improvements on a neural network-based detector.



Physics' **Ravinraj S/O RAMARAJ** designed and built an experimental platform to probe and manipulate ultracold strontium atoms, for use in quantum information processing experiments.

SPORTS CHAMPIONS

Kiria Tikanah ABDUL RAHMAN, Chemistry Year 2, has been on the national team since 13. She has won multiple gold medals in numerous national championships and competitions. In the latest feather in her cap, she clinched the championship in the women's epee final event at the Southeast Asian Games (SEA Games) (2019), a historical achievement as it was the first gold medal for Singapore since 1989. It was a hard-fought game where she locked horns with an Olympian. Kiria is now training for the 2024 Summer Olympics.



National netballer **Jamie LIM**, Statistics Year 2, clinched the Silver (Team) award at SEA Games (2019). She has been a netballer for 10 years, during which she participated in 11 international competitions and was in the championship league in the ASEAN Schools Games (2015, 2018) and the Nations Cup (2019). Jamie received the Singapore Schools Sports Council Best Sportsgirl Award (2018).

HEART FOR THE COMMUNITY

When she realised that six people are diagnosed with bone marrow diseases every day, **Shivani MEKAVATHANAN**, a fresh Life Sciences (Minor in Psychology) graduate, initiated NUS' first Bone Marrow Donor Day (BMDD) on 1 and 2 October 2019. BMDD garnered over 100 donors, raised \$200 and reached over 300 students to educate them on donation misconceptions.



Fresh Physics graduate **Muhammad Arif Bin Muhammad Isa ER** serves the community as a volunteer firefighter with the Singapore Civil Defence Force Singapore. He has attended to fire or hazardous materials incidents, including the Fan Yoong Road warehouse and 48 Tuas Crescent fires in 2014 and 2019, respectively. He also conducts spot checks and on-site workshops for organisations in zonal areas. Arif hopes to raise awareness of the importance of frontline firefighting volunteerism in Singapore.



STUDENT ENTREPRENEUR

HENG Chin Wee, a fresh Food Science and Technology graduate, co-founded HEFTI (Healthy, Environmentally-Friendly, Tasty and Innovative) in 2019 to add value to food-processing byproducts such as okara, by turning them into innovative food ingredients. This reduces food waste. HEFTI is one of the award recipients of Youth Co:Lab (Singapore), a joint initiative by the United Nations Development Programme and Citi Foundation in the Youth Action Challenge (2020). Chin Wee is now formulating recipes that are gluten-free and vegan friendly.



YOUNG ENVIRONMENTALIST

Fresh Environmental Studies graduate **DENG Yimin** was President, NUS Students Against the Violation of the Earth (NUS SAVE), where she spearheaded campus sustainability campaigns. She also represented university youth environmental clubs to develop South West Community Development Council's Eco Plan. Together with her team, GreenKey, she developed tools to increase Small and Medium Enterprises' (SMEs) access to green finance instruments for sustainable business transformations.



COMMUNITY CONTRIBUTING TO SOCIAL GOOD

Several creative ground-up projects by NUS Science graduates were nominated under NUS' Resilience and Growth (R&G) Innovation Challenge for their potential to address various societal issues. With R&G funding, they can translate their ideas into reality, to positively impact society.

SENIORZONE APPLICATION (APP)

Nurul Sa'idah BINTE ARSAD, a fresh Mathematics graduate, is a member of a team that is developing an app to promote well-being in seniors. The app will provide information on activities and meeting opportunities, serving as a platform for the elderly to network and socialise with friends, and develop hobbies.

Nurul said, "We would like to help the vulnerable elderly, by addressing the monotony and loneliness in their daily lives which affect their mental and physical health."



CAHAYA COMMUNITY

Life Sciences graduate **Sheriff QUEK** is a leader in Cahaya Community, a volunteer organisation that helps low-income families in public rental flats in Kebun Baru and Canberra. The idea was sparked after Member of Parliament Mr Henry KWEK highlighted the need to academically support marginalised families there. Cahaya Community provides holistic family support through interconnected initiatives, including mentorship, livelihood support, character development and sports programmes. The team plans to reach out to more families, and expand operations.

Sheriff said, "By promoting parent-child bonding, we hope to cultivate positive social-emotional values that contribute to stronger families."



SUSTAINABLE PALM OIL



The burning of forest habitats to clear land for oil palm plantations is a leading contributor to transboundary haze. A team of student advocates plans to engage stakeholders through talks and social media to promote the consumption of palm oil certified by the Roundtable of Sustainable Palm Oil.

The Science team comprises **Vanessa CHIA** (Double Majors in Food Science and Technology, and Life Sciences), **LAI Hong Hui** (Environmental Studies) and **MA Hongxia** (Double Majors in Statistics and Economics). They plan to engage government agencies and businesses, as well as work with advocacy groups to expand their network and initiatives.

Vanessa said, "We hope to raise public awareness of how unsustainably-produced palm oil contributes to transboundary haze, and the need to switch to sustainable alternatives to protect our environment."

ECO-PACK



Life Sciences graduate **Edwin WONG** and his team designed Eco-Pack to address the pressing issue of packaging waste in Singapore. Eco-Pack is made with hardy material, enabling e-commerce merchants to reuse it for multiple deliveries. It is also designed to reduce the space needed for bulky packaging materials.

Edwin said, "We hope to contribute to sustainable business practices and environmental conservation by recycling resources."

COMMUNITY INNOVATING PEDAGOGY



Through collaborative tools, livestreaming classes and advanced technologies, our educators creatively redesign classes by integrating online and in-person learning. The Faculty's early adoption of technology enabled our educators to quickly adapt during the pandemic.

"COOKING SHOW" APPROACH

In many experimental science modules, experiential learning takes the form of laboratory-based classes. With laboratory sessions curtailed by safe distancing measures, Prof **HO Han Kiat**, Department of Pharmacy, focused instead on the theoretical aspects of experiment design and data analysis using video-based teaching. The videos guided students through experimental techniques. Students were provided data from the experiments to complete their analysis (pg 39).



SHOEBOX SCIENCE

Prof **SOW Chong Haur**, Department of Physics, took experiments to students' homes. Custom-designed kits on electromagnetics, optics and solid state physics experiments were mailed to undergraduates, and students conducted virtual experiments together with instructors in synchronous online tutorials. These science demonstrations allow students to get as closely to the real experience as possible, and promote interactive teacher-student e-exchanges (pg 12).

VIRTUAL REALITY

Prof **Stella TAN**, Department of Biological Sciences, offers a Forensic Science module on Forensic Toxicology and Poisons using immersive technology to engage students. A virtual reality (VR) crime scene is created, enabling students to collect evidence in the virtual environment for analysis and reconstruction. Web-based VR also enables students to view the immersive learning experience remotely with their mobile phones.



IMMERSIVE LEARNING

Profs **ZHOU Weibiao** and **YANG Hongshun**, Department of Food Science and Technology, designed virtual laboratory exercises and an interactive platform to teach food processing and engineering. This helps maintain the quality of students' learning outcomes when there is limited time and laboratory space, and enables students to grasp complex scientific concepts in an immersive environment.

INDIVIDUALISED HOMEWORK ASSIGNMENTS

Data analysis is an important workplace skill. To acquire this skill, students need to understand its common applications to problem-solving in different domains. Prof **Adrian Michael LEE**, Department of Chemistry, scaffolded the learning of data analysis using individualised homework assignments. This approach achieved large learning gains and improved the understanding of core concepts (pg 33).





COMMUNITY RECOGNISING EXCELLENCE



Our faculty members are widely recognised by their peers for their achievements and enjoy high international standing. Our reputation for excellence was reinforced through various prestigious awards for our faculty members' exceptional contributions to science and research, and for outstanding service to Singapore.



Chevalley Prize

Prof **BAO Huanchen**, Department of Mathematics, was jointly awarded the Chevalley Prize in Lie Theory (2020) of the American Mathematical Society with Prof WANG Weiqiang, University of Virginia, USA, for their fundamental contributions to the theory of quantum symmetric pairs. They were recognised for extending completely the known theory of canonical bases from quantum groups to quantum symmetric pairs (pg 38). Prof Bao is also an NUS Presidential Young Professor.



Fellow of American Statistical Association (ASA)

Prof **LI Jialiang**, Department of Statistics and Applied Probability, was elected as an ASA Fellow (2020), for outstanding contributions to statistical methodology and sustained research and collaboration involving statistical analysis of medical data. ASA is the world's largest community of statisticians. The ASA Fellowship has been a significant honour, the highest in the association, for nearly 100 years (pg 43).



Fellow of The World Academy of Sciences (TWAS)

Prof **SHEN Zuowei**, Department of Mathematics, was elected as a TWAS Fellow (2020) for his fundamental contributions in the mathematical foundations of data science, especially in the areas of approximation and wavelet theory, image processing and compressed sensing, computer vision and machine learning (pg 38).



L'Oréal-UNESCO International Awards For Women in Science

Prof **LOH Huanqian**, Department of Physics, was named among "15 Rising Talents" worldwide by the UNESCO and L'Oréal Foundation's For Women in Science programme (2020). Her laboratory focuses on using tweezer arrays of atoms and molecules as quantum lego blocks to perform quantum simulations of advanced materials (pg 41).

NUS PRESIDENTIAL YOUNG PROFESSORSHIP (PYP)

In Academic Year 2019/2020, three young academics with excellent research track records in their respective fields were appointed as PYPs.

Prof **XUE Shifeng**, Department of Biological Sciences, studies how specific genes are kept in an off state during embryonic development. This is important as derepression of unwanted genes during embryogenesis can cause numerous birth defects. She is a recipient of the Young Scientist Award (2018) by the Singapore National Academy of Science.

The other two recipients are Prof **BAO Huanchen**, Department of Mathematics, and Prof **Yvonne GAO**, Department of Physics.



President's Science Award

Prof **TOH Kim Chuan**, Department of Mathematics, was conferred the President's Science Award (2019) for his outstanding work in the field of computational optimisation. A world leader in algorithms for convex optimisation, especially in semi-definite programming, Prof Toh has made fundamental contributions to the theory, practice and application of this research (pg 38).



Returning Singaporean Scientists Scheme

The National Research Foundation (NRF) scheme seeks to attract outstanding overseas-based Singaporean research leaders back to Singapore to take up leadership positions in our autonomous universities and publicly funded research institutes. Conservation scientist Prof **KOH Lian Pin** is the sixth Singaporean to return home since the scheme's inception in 2013.



NRF Investigatorship

Prof **Shaffique ADAM**, Department of Physics, received the NRF Investigatorship (2020), which is awarded to mid-career scientists for the pursuit of groundbreaking research. He is interested in exploring the complex ways electrons behave when they are subject to the interplay of quantum mechanics, material imperfections, confined geometries and interactions with other electrons (pg 41).



NRF Fellowship

Prof **Gloryn CHIA**, Department of Pharmacy, received the NRF Fellowship (2020) for improving the efficacy of neoantigen vaccines, with the ultimate aim of translating the research into personal cancer treatments (pg 39).



NRF Fellowship

Prof **Yvonne GAO**, Department of Physics, received the NRF Fellowship (2020) for constructing cutting-edge 'quantum hardware' for scalable quantum computing (pg 41). Prof Gao is also an NUS Presidential Young Professor and a recipient of the Innovators Under 35 Asia Pacific award (2020) by MIT Technology Review.

NATIONAL DAY AWARDS

The National Day Awards recognise various forms of merit and service to Singapore.



Public Administration Medal (Silver)

Prof **XU Guo Qin**
Department of Chemistry



Commendation Medal

Ms **CHEW Ying Ying**
Department of Pharmacy



Efficiency Medal

Ms **LAU Siew Keok**
Department of Physics

COMMUNITY MAKING A MARK



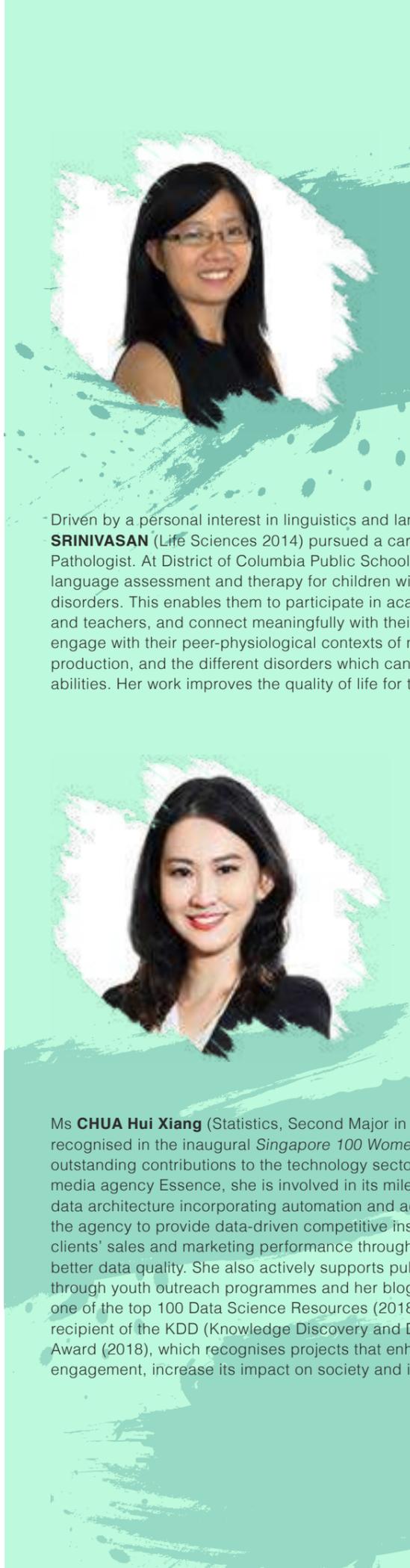
Many of our alumni are leaders and game-changers in their respective fields. All of them make impactful contributions, across industries and professions.

Prof **LOH Xian Jun** (Chemistry 2006), a pioneer in the area of biodegradable thermogels, is Executive Director, Institute of Materials Research and Engineering (IMRE), Agency for Science, Technology and Research (A*STAR). Prof Loh is developing a thermo-gelling biomaterials system that can regenerate the vitreous in the eye. This will revolutionise the treatment of retinal detachment in the future. During COVID-19, he invented a smart mask allowing remote monitoring of patients' vital signs, which reduces infection risks for frontline workers. His scientific contributions earned him the Fellowship in Fitzwilliam College, University of Cambridge. He was also awarded the Highly Cited Researcher Award by Clarivate Analytics (2019, 2020).



Ms **JIANG Yifan** (Food Science and Technology 2012) is Head (Science and Regulatory Affairs) at non-profit association Food Industry Asia (FIA). She provides science-based advocacy to promote regional and global regulatory harmonisation in platforms such as the Codex Alimentarius Commission, which implements the international food standards programme. Yifan also leads FIA's food safety capacity building programmes and training initiatives with regulatory agencies and multilateral partners to strengthen food safety legislative frameworks in Asia's complex regulatory environment.

Ms **Laurentcia ARLANY** (Physics 2016) is a Medical Physicist and Hospital Radiation Safety Officer at Sengkang General Hospital, where she focuses on medical physics and radiation safety. At the hospital, she manages quality control checks for imaging equipment, monitors workers' exposure to radiation and investigates accidental exposure amongst staff and patients. She also conducts courses to increase staff awareness of radiation safety practices.



As Chief Data and Analytics Officer at Moka Technology Solutions Pte Ltd, a point-of-sale payment startup, Ms **Geraldine CHIA** (Mathematics, Minor in Computational Science 2001) built the company's data strategy and infrastructure from scratch. When ride-hailing unicorn Gojek acquired Moka in 2020, Geraldine concurrently assumed the position of Head of Data (GoMerchants), where she uses data science and analytics to better understand customer behaviour and reduce merchant churn. Drawing on both companies' combined expertise, she hopes to help Indonesia's underserved merchants and small and medium businesses by linking them with drivers and users through an integrated suite of cloud-based solutions.

Driven by a personal interest in linguistics and language acquisition, **Nandini SRINIVASAN** (Life Sciences 2014) pursued a career as a Speech Language Pathologist. At District of Columbia Public Schools, she provides speech and language assessment and therapy for children with communication and swallowing disorders. This enables them to participate in academic activities with their peers and teachers, and connect meaningfully with their communities. They can also engage with their peer-physiological contexts of normal speech and language production, and the different disorders which can affect their communication abilities. Her work improves the quality of life for these children.



Prof **Valerie CHEW** (Pharmacy 2003) is a Senior Research Scientist at SingHealth Translational Immunology and Inflammation Centre and holds a concurrent appointment at Duke-NUS Medical School. She is a pioneer in cancer immunology, focusing specifically on hepatocellular carcinoma (liver cancer). Her research contributes to holistic understanding of complex immune landscapes and the identification of clinically relevant biomarkers that predict tumour progression and therapeutic responses. Her landmark findings on liver cancer therapy have been in use for over a decade. Prof Chew's work has gained international recognition with multiple grant awards and high impact publications, like *Proceedings of the National Academy of Sciences (PNAS)* and *Gut*.

Ms **CHUA Hui Xiang** (Statistics, Second Major in Management 2012) was recognised in the inaugural *Singapore 100 Women in Tech* list (2020) for her outstanding contributions to the technology sector. As Senior Analytics Manager at media agency Essence, she is involved in its milestone efforts to develop a robust data architecture incorporating automation and advanced analytics. This enables the agency to provide data-driven competitive insights that significantly improve clients' sales and marketing performance through cost and time savings, and better data quality. She also actively supports public education in data science through youth outreach programmes and her blog, which has been recognised as one of the top 100 Data Science Resources (2018, 2019). Hui Xiang was a recipient of the KDD (Knowledge Discovery and Data Mining) Impact Programme Award (2018), which recognises projects that enhance data science community engagement, increase its impact on society and influence public policy.





ENTERPRISE DARING TO DREAM

Some of our alumni have ventured into the unknown by starting their own businesses. Others have transformed their technologies and talents into deep technology startups through the NUS Graduate Research Innovation Programme (GRIP). All of them have chartered their own paths in the unknown.



AVENEVV

Mr **Aaron KHOO** (Quantitative Finance and Economics 2018) co-founded Avenevv in March 2018 to provide a one-stop online marketplace for MICE (Meetings, Incentives, Conferences, Exhibitions) planners to discover curated event venues and packages, and seamlessly manage enquiries, bookings and payments end-to-end. He plans to extend Avenevv's market penetration locally, and to upscale across different verticals and countries in the long run. To date, Avenevv has more than 250 MICE partners from an extensive network of event venues, and service and technology providers.



OLEUM LEVO PTE LTD

Mr **Kelvin LING** (Chemistry, Minor in Business Management 2011) co-founded clean technology company Oleum Levo this year, which uses specially designed membrane technology for oily wastewater treatment. The cost-effective and reusable filter ensures that oil pollution does not destroy the marine ecosystem by providing clean and safe water in an environmentally sustainable way. Oleum Levo plans to create its first commercial membrane product for a pilot project with an engineering firm.



NUSOIL PTE LTD

Dr **TAN Wee Kee** (Plant Biology*, Minor in Agrotechnology 1999) co-founded NuSoil in 2019 and is part of a team that converts food waste into an eco-friendly gel which promotes plant growth even under harsh drought conditions. The patented InnoGro® soil supplement retains moisture in the growing substrate for longer periods of time and minimises nutrient leakage. NuSoil was one of the Top 100 Global Startups in international competition SLINGSHOT (2019) and has successfully raised seed funding. It plans to scale up manufacturing capability, commercialise InnoGro® and develop other products for sustainable food production.



ALCHEMY FOODTECH PTE LTD

Ms **Verleen GOH** (Food Science and Technology 2010) co-founded Alchemy Foodtech, with a mission to use food science/technology to fight lifestyle diseases. To combat diabetes, her team created Alchemy Fibre, a patented ingredient that is gluten-free and made from plant crops, to lower the glycaemic index (GI) of refined carbohydrates. This innovation raises the overall fibre content without compromising on taste and texture. They have also launched new baking premixes and ingredient blends that include Alchemy Fibre. The team will continue to work with food manufacturers to create healthier versions of their products.



NUSMETICS PTE LTD

Current skincare solutions rely on chemical enhancers which can cause irritation. Dr **Himanshu KATHURIA** (Pharmacy 2018) co-founded NUSMETICS in 2019 to reduce the use of harmful chemicals in the cosmeceutical industry. Its Microbee™ delivery platform has spikes of tailored depth and size to open up self-sealing micro-sized channels on the skin's surface. This breakthrough technology enhances the efficacy of personal care products, to nourish skin from within. NUSMETICS has received grants from Enterprise Singapore and the National Additive Manufacturing Innovation Cluster to scale up production. It is also raising funds to bring its first product to market.



SKYTREK SYSTEMS PTE LTD

An interest in robotics and unmanned aerial vehicles, and their applications led Dr **Seth POH** (Physics 2005) to invent a technique that allows drones to land within target accuracy of centimetres. He set up SkyTrek in 2019 to develop a sensor and drone solution to convey maritime supplies between ships in anchorage and shore. This service is expected to reduce the carbon footprint in shipping, and alleviate maritime traffic congestion. Dr Poh is working with maritime partners to commercialise the service. He is also exploring developing drone delivery applications for medical supplies.



STARTUPX PTE LTD

Ms **Joyce TAY** (Statistics 2010) launched StartupX in 2018, following a decade growing one of the largest startup communities in Asia. StartupX partners with corporations around the world to drive impactful innovation. Joyce pioneered the startup pre-accelerator model in Southeast Asia to bridge the early-stage gap in the startup ecosystem. In 2019, StartupX together with investment company Temasek launched the world's first hackcelerator for sustainability-driven startup to support innovations towards the United Nations Sustainable Development Goals. StartupX has worked with over 3,000 founders internationally, and its startups are supported by over 250 corporate leaders in the region.



DEPARTMENT OF BIOLOGICAL SCIENCES

EXECUTIVE SUMMARY

The Department of Biological Sciences continues our strategic thrust of preparing students for professional life and equipping them to venture into exciting industries. We continue to anchor a vibrant, diverse and dynamic research community that takes the lead in addressing life sciences research in human health, climate change and food security. We are also contributing towards the COVID-19 fight through research in immunotherapies.

EDUCATIONAL MILESTONES

The credit-bearing Life Sciences Industry Seminar module, launched this year in collaboration with the Centre for Future-ready Graduates, links undergraduates with career practitioners in various life sciences industries who share insights into industry trends, challenges and career opportunities.

In addition to drug discovery and development, our Joint Degree Programme with University of Dundee now has two more focus areas - developmental biology and plant science. We also welcomed the inaugural intake for our M.Sc. (Coursework) degree in the cross-disciplinary field of forensic science (pg 15). M.Sc. (Coursework) degrees in environmental sustainability and biotechnology will be launched in the near future.

We will also launch a Minor in Bioinformatics in Academic Year 2021/2022, which provides broad coverage of the theory and applications of bioinformatics in fields related to the life sciences and medicine. It will train students from multiple disciplines to become bioinformatics professionals, a growing area of expertise (pg 7).



KEY EVENTS



‘A Date with DBS’

In addition to online talks to engage schools, we held a series of webinars with our alumni, customised to add value to job search capabilities. The webinars included sharing sessions, consultations and clinics by alumni, industry leaders and employers. The series kicked off in June for our Class of 2020.

Prof
YU Hao
Head



COVID-19 RESEARCH

Cellular immunotherapies for severe COVID-19

Prof **WANG Shu**, in collaboration with local biotechnology company CytoMed Therapeutics Pte Ltd, was recently granted funding from the National Medical Research Council (NMRC) to develop an immune cell therapy against severe COVID-19. CytoMed leverages its patented technologies to develop gamma delta ($\gamma\delta$) T cell- and natural killer cell-based “off-the-shelf” immunotherapeutics for a wide range of diseases, including cancers and infectious diseases. Its’ GMP (Good Manufacturing Practice) facility will be used to manufacture immune cells developed in the NMRC project if the product progresses to clinical trials.



RESEARCH ACHIEVEMENTS

Understanding how skin ages

Prof **CHEW Fook Tim** is collaborating with Procter & Gamble, a world leader in fast moving consumer goods, to evaluate the underlying factors associated with skin ageing in Asians. To kick off the long-term multipronged collaboration, the team will initiate a prospective cohort study on how a stressful lifestyle affects the skin. This work will tap on the large-scale evaluation of the epidemiology of skin physiology and genetics, and detailed skin functional work in Asian populations over the years (pg 17).



New songbird species discovered in Wallacea

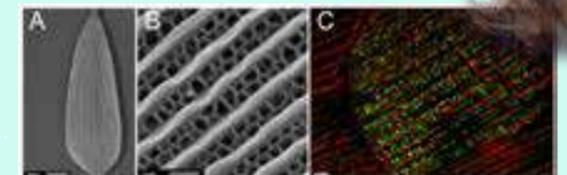
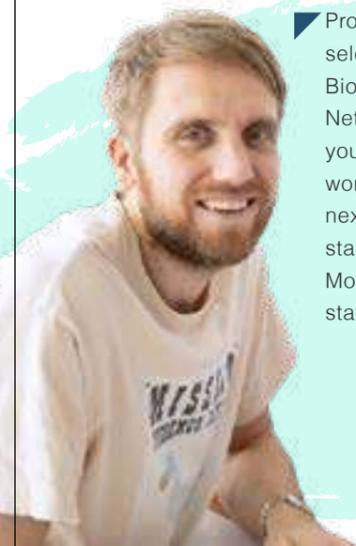
Prof **Frank RHEINDT** and his collaborators from NUS, the Indonesian Institute of Sciences, and Wildlife Reserves Singapore, described five new songbird species and five new subspecies from three small satellite islands near Sulawesi, Indonesia, whose DNA was collected during a single six-week expedition. This marks the first time in about 120 years that this many new birds have been described in a small geographic area. This can be attributed to our knowledge of quaternary land connections which helped pinpoint isolated islands likely to harbour substantial endemism, and a study of accounts of historic collectors like Alfred Russel WALLACE which facilitated the identification of undercollected islands. The findings were published in *Science* (January 2020).



AWARDS AND ACCOLADES

Prof **Timothy SAUNDERS** was selected to join the European Molecular Biology Organisation Global Investigator Network, a new programme connecting young research group leaders across the world. This new programme supports the next generation of scientific leaders who started their laboratories in European Molecular Biology Conference member states.

Final year Ph.D. student **SEAH Kwi Shan** was awarded a research grant for her work on butterfly wing scales. It was the only project outside of North America selected for the Society for the Study of Evolution’s Rosemary Grant Advanced Award. She was mentored by Prof **Vinod Kumar SARANATHAN**.



DEPARTMENT OF CHEMISTRY

EXECUTIVE SUMMARY

The Department of Chemistry is contributing to the body of research to study COVID-19, while continuing to actively publish in prestigious international journals. We also secured over \$15 million in research funding and recruited new faculty members to augment our talent pool for future educational and research initiatives.

EDUCATIONAL MILESTONES

Our undergraduate programme offers students many options, such as diverse modules and specialisations, and research projects, amongst others. From this year, students can embark on new projects in translational research, Machine Learning, Artificial Intelligence and data analytics in chemistry.

The Computational Thinking module, which focuses on the connectivity between real-life chemistry problems and data analysis, continues to attract more students.

We also boosted our internship programme, with more companies representing different sectors coming onboard.

AWARDS AND ACCOLADES

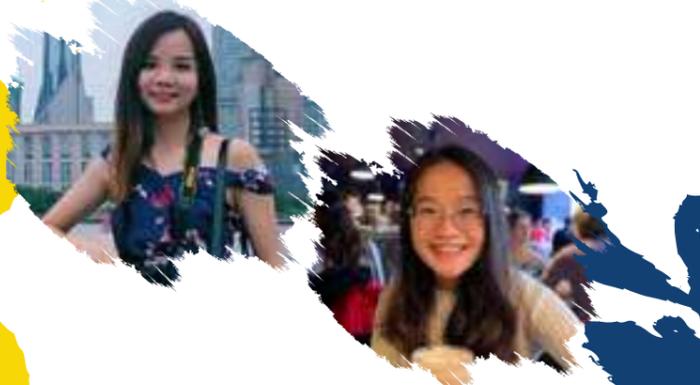


Prof **JJ VITTAL** received The Chemical Research Society of India Medal (2020), which is awarded to outstanding chemists of Indian origin working outside India, for his work on crystal engineering and solid state reactivity.

In December 2019, alumna Ms **KOH Rui Lin** and Prof **Adrian Michael LEE** received the Best Poster prize at the 36th International Conference on Innovation, Practice and Research on the use of educational technologies in tertiary education.

The poster was based on Rui Lin's final year project under Prof Lee's supervision, on scaffolding the learning of data analysis using individualised homework assignments (pg 24).

Year 3 students **Christine NG** (bottom left) and **FANG Wen** (bottom right) and their respective teams emerged as the first runner-up in the NUS Entrepreneurship Society's annual Ground Zero event for university students to translate their startup ideas into business solutions.



Prof Richard WONG
Head



COVID-19 RESEARCH

Detecting virus signatures

Prof **Guillermo BAZAN** is collaborating with the Institute of Chemistry, Chinese Academy of Sciences, China to simplify and increase the sensitivity of reverse transcriptase polymerase chain reaction (RT-PCR) tests that detect COVID-19 infections. This involves simplifying the RT and amplification procedures by using smart enzymes and constant temperatures, together with the use of light harvesting materials that optically amplify fluorescent signatures that detect the presence of the virus.



RESEARCH ACHIEVEMENTS

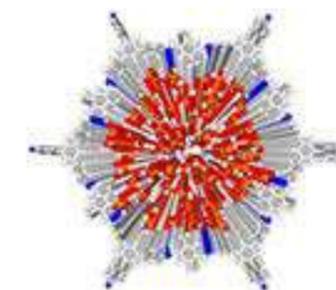
Transparent LEDs for smart wearable devices

Prof **TAN Zhi Kuang's** research team has developed high-efficiency light-emitting diodes (LEDs) which are transparent across the visible light spectrum. This may replace conventional non-transparent chip-based LEDs, thus opening up a range of interesting new applications in wearable and mobile gadgets. Their LEDs employ a novel perovskite-based semiconductor that is capable of intense and efficient light emission. The team has also achieved high optical transparency through a new multilayered electrode. These high-performance LEDs may be applied in facial recognition, eye-tracking, motion sensing and health-tracking technologies in smart devices. This work was published in *Nature Communications* (August 2020) and *Nature Photonics* (December 2019).



Generating green energy

Proton transport is key to fuel cells that convert chemical energy to electricity in a sustainable way. Despite a long research history in chemistry and materials science, merging stability with proton transport properties remains challenging. Prof **JIANG Donglin**, together with postdoctoral fellow Dr **TAO Shanshan** discovered a new way to combine stability and proton transport properties by designing a novel covalent organic framework. The resulting materials enable ultrafast proton transport to reach a level for practical use in fuel cells. This study is a start line for developing proton-transporting materials and their implementations. This work was published in *Nature Communications* (April 2020).



Cobalt walks on a chain

Organoboron compounds play an important role in chemical synthesis due to their low toxicity and stability. Geminal organodiboron compounds, a special class of organoboron compounds with two boron atoms on the same carbon, have emerged as versatile building blocks for organic synthesis. Prof **GE Shaozhong** and Dr **HU Ming** recently developed an effective methodology to prepare such geminal organodiboron compounds through catalytic double hydroboration of diene molecules with a cheap and readily available cobalt catalyst. This work was published in *Nature Communications* (February 2020).



KEY EVENTS



NUS Chemistry Award and Appreciation Lunch

At the lunch on 17 January, 14 Chemistry Alumni Study Awards, two scholarships and four bursaries were presented.

16th Conference of the Asian Crystallographic Association (AsCA)

The 16th AsCA, which provides a platform for researchers to present recent research findings in crystallography, was jointly organised by the department and the Singapore National Institute of Chemistry in December 2019.

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

EXECUTIVE SUMMARY

The Department of Food Science and Technology (FST), previously the NUS-FST Programme, officially commenced operations in January. It is currently the only department of its kind in Singapore's tertiary education landscape. Our inception as a full-fledged department is a timely one, reflecting our leading role in the discipline and our ongoing efforts to enhance our regional competitiveness. Our faculty members continue to work towards positioning the department as a centre of excellence in food science and technology with well-sought after graduates and research of international impact.

EDUCATIONAL MILESTONES

Our internationally accredited curriculum offers multidisciplinary and problem-based learning, internship exposure and various academic and non-academic training opportunities to prepare our graduates for the fast-growing food industry. Undergraduate intake has grown over the last two years, and we expect this upward trend to continue. The M.Sc. in Food Science and Human Nutrition programme has seen a threefold increase in enrolment since its inception in 2018 (pgs 8 and 16).



**Prof
ZHOU Weibiao**
Head

AWARDS AND ACCOLADES



Prof **YANG Hongshun** received the Institute of Food Technologists (IFT) Aquatic Food Products Division Outstanding Volunteer Award in July. He chaired the graduate poster competitions in 2019 and 2020, and was elected as Chair Designate for IFT AFPD (2020-2021). He is also an editor for *LWT-Food Science and Technology* and editorial board member for the *Journal of Food Science*.

Ph.D. student **CHUA Jian Yong** was named to the *Forbes 30 Under 30 Asia* (2020) list for SinFooTech, a food biotechnology startup he co-founded in March 2018. SinFooTech focuses on food valorisation projects to promote food sustainability. Its first product, *Sachi*, is a novel alcoholic beverage made from soy whey.



Ph.D. student **Darel TOH** was one of four finalists for the American Society of Nutrition's Clinical Emerging Leaders Award, which promotes interest in clinical and human nutrition amongst graduate students. Darel was also a finalist in Emerging Leader in Nutrition Science, which recognises young investigators with top quality research.

COVID-19 RESEARCH

Rethinking disinfection

Dr **Vinayak GHATE's** (centre, seated) patented visible light technology reduces infection risks by killing bacteria, fungi and viruses in hygiene-sensitive environments while being safe for human use. It is part of an emerging category of continuous disinfection technologies, which work round-the-clock to ensure that once a surface is sanitised, it stays sanitised. The technology can be easily adapted for use in different industries, including healthcare and public transport, among others.



RESEARCH ACHIEVEMENTS

Changing what we eat

Prof **HUANG Dejian's** team is working towards commercially viable seafood mimics by the end of 2020. They have made good progress in applying 3D food printing and enzyme technology to convert plant-based ingredients into vegetable fishballs and salmon mimics. They also developed edible inks for the fabrication of scaffolds and microbeads for culturing laboratory-based meat. Their project is supported by a grant from the Agency of Science, Technology and Research (A*STAR).



Better gut health with probiotic coffee

Prof **LIU Shao Quan's** team devised a novel technique to culture live probiotics in coffee. Ongoing research suggests the retention of beneficial health properties in the cultured coffee brews. The team hopes to diversify the range of probiotic foods in the market. They have filed a provisional patent for their research.



Sweet, yet healthy

To reduce the incidence of diabetes, Dr **GAO Jing** and Ph.D. student **JIN Xiaoxuan** founded AuroraFood, a food technology platform that transforms sweet indulgences into healthier and diabetic-friendly food choices. Their proprietary formulations contain active ingredients that are natural, tasty and effective in slowing down sugar release from bakery products. The team will be launching their first product, *JoieJoy* baking mix, to premium bakery lines. AuroraFood is a startup under the NUS Graduate Research Innovation Programme to cultivate deep technology entrepreneurs.



KEY EVENTS

12th Joint International Symposium on Food Science and Technology

We hosted the event on 1 to 2 December 2019, which drew over 100 attendees from local and 10 overseas universities in the Asia Pacific region. There were 47 presentations, of which eight student presentations received awards.



'Root of Food'

The FST Society organised its first outreach programme for junior college students in January, to generate deeper understanding of our programme. The event featured hands-on stations in food microbiology, individual body nutritional assessment, sensory evaluation and pastry baking.



DEPARTMENT OF MATHEMATICS

EXECUTIVE SUMMARY

The Department of Mathematics is undertaking research to address COVID-19, while continuing to engage in fundamental and interdisciplinary research in strategic areas relevant to Singapore's economy. Our faculty members continue to chair prestigious international editorial boards. According to Quacquarelli Symonds, Mathematics at NUS retained its top ranking in Asia and 13th in the world for three consecutive years.

EDUCATIONAL MILESTONES

Together with the Department of Statistics and Applied Probability, and the Department of Computer Science in the School of Computing, we are jointly offering the M.Sc. in Data Science and Machine Learning from Academic Year 2020/2021. This interdisciplinary graduate degree programme transforms graduates with Bachelor degrees in quantitative disciplines into practitioners adept at solving real-world data-driven problems in different industries. The programme received overwhelming response, with over 800 applicants in its inaugural run (pg 15).

KEY EVENTS

Young Mathematician Lecture Series



We started this series in June, amidst COVID-19 restrictions. The lecture series introduces promising young mathematicians and is also an avenue to invite potential candidates to take up junior positions in the department. So far, we have invited Profs ZHANG Ruixiang, University Wisconsin-Madison; YAO Yao, Georgia Institute of Technology; HUANG Hao, Emory University; WANG Hong, Princeton University; and CUI Ying, University of Minnesota.



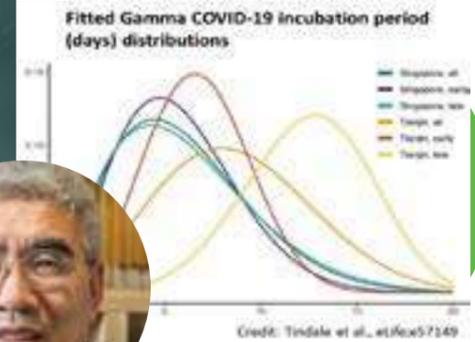
Prof TOH Kim Chuan
Head



COVID-19 RESEARCH

Modelling the virus transmission

Prof **ZHANG Louxin** is part of the international research team studying the estimation of the serial interval and incubation period of COVID-19 from early clusters of cases in Singapore and Tianjin, China. Both parameters are widely used for surveillance and control of the disease. The team estimates the incubation period for COVID-19 is between five and eight days, and the serial interval is about four days. About 40% to 80% of transmission occurs two to four days before an infected person has symptoms. The study, published in *eLife* (June 2020), suggests that public health measures to prevent pre-symptomatic transmission are essential.



RESEARCH ACHIEVEMENTS

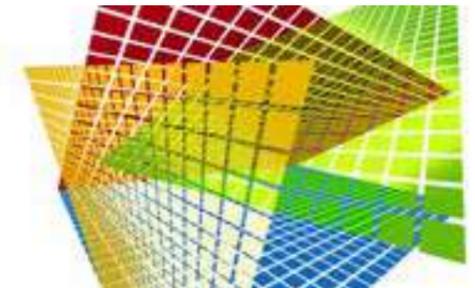
A new model for directionality in data

Determinantal point processes (DPPs) have emerged as popular tools to model the phenomenon of negative dependence, or repulsion, in data. Prof **Subhro GHOSH** and his co-author Prof Philippe RIGOLLET, Massachusetts Institute of Technology, introduce a simple and flexible Gaussian DPP model to capture directionality in data. This model is a viable alternative to principal component analysis, as a dimension reduction tool that favours directions along which the data are most spread out. These investigations unveil intriguing questions for further examination in random matrix theory, stochastic geometry, and related topics. The results were published in the *Proceedings of the National Academy of Sciences* (June 2020).



Cuspidal automorphic representations of classical groups

In representation theory, a classical question is to construct concrete modules for irreducible representations of groups. To address this question for automorphic representations of classical groups, Prof **ZHANG Lei** and his co-author Prof JIANG Dihua, University of Minnesota, established a twisted descent theory and proved one direction of the celebrated global Gan-Gross-Prasad conjecture as an application. The results were published in *Annals of Mathematics* (May 2020).



AWARDS AND ACCOLADES



Prof **SHEN Zuwei** was elected a fellow of The World Academy of Sciences, a global science academy which brings together the world's most accomplished scientists to address challenges in developing countries (pg 25).



NUS Presidential Young Professor Prof **BAO Huanchen**, jointly with Prof WANG Weiqiang, University of Virginia, received the American Mathematical Society Chevalley Prize in Lie Theory (2020) for their fundamental contributions to the theory of quantum symmetric pairs (pg 25).



Prof **TOH Kim Chuan** was conferred the President's Science Award (PSA) (2019), for his groundbreaking and internationally recognised work in computational optimisation and semi-definite programming. PSA is presented to research scientists in Singapore whose work has resulted in significant scientific, technological or economic benefits for the country (pg 26).



Our undergraduates participated and won prizes for the third consecutive year in the Simon Marais Mathematics Competition (2019). **YAP Jit Wu** (left) placed fourth (Individual Prize), while **LIM Li** (centre) and **LING Yan Hao** (right) took seventh place (Pairs Prize). It was also the first time that NUS qualified for, and clinched, the top place in the University Prize category. Jit Wu was also one of four gold medallists in the Alibaba Global Mathematics Competition (2020), which seeks to promote a deeper understanding of mathematics in the global technology community.

DEPARTMENT OF PHARMACY

EXECUTIVE SUMMARY

The Department of Pharmacy's vision is to lead in shaping healthcare and related industries through innovative pharmaceutical education, research and practice. We transformed our flagship undergraduate Pharmacy programme to provide our students broader exposure to the changing healthcare landscape shaped by rapid technological advances. The revamped programme, the first in Asia to feature an integrated, inter- and transdisciplinary curriculum, will receive its inaugural intake in August (pg 7). Our local and global standing - strengthened through alumni engagement, international conferences, workshops and exchanges - has led to new collaborations for research, education and practice.

EDUCATIONAL MILESTONES

Our B.Sc. in Pharmacy programme is renamed as B.Pharm., to reflect its pedagogical and content overhaul. It integrates basic, clinical and systems sciences, and comprises extensive team-based learning, an expanded and phased-in internship from Year 1, and future-centred training focusing on in-demand skills and attributes aligned more closely with desired professional outcomes. Concurrently, we embarked on a year-long #PassionPridePurpose publicity campaign to reinstate professional pride in the identity of pharmacists.

Our M.Sc. in Pharmaceutical Science and Technology programme provides a flexible and stackable route for part-time learners to upskill and reskill. To widen options for adult learners, we also launched the Graduate Certificate (GC) in Pharmaceutical Process and Technology (pg 16). Another two clinical pharmacy-related GCs were approved: Advanced Pharmacy Practice, and Community-based Geriatric Pharmaceutical Care, with the first intakes in August. These programmes are endorsed by the Singapore Pharmacy Council.

COVID-19 has propelled e-learning and educational innovations to the fore. We moved all didactic teachings online within a short time, and adopted creative alternatives to practice-related and laboratory-based classes. Dr **HAN Zhe** and Dr **YAP Kai Zhen** moved a role-playing exercise online, and Prof **HO Han Kiat** adopted a "cooking show" demonstration to blend laboratory learning with in-class data analysis (pg 24).

AWARDS AND ACCOLADES



Prof Christina CHAI
Head



Prof **Gloryn CHIA** received the National Research Foundation Fellowship (2020) for her work on neoantigen vaccines (pg 26). She was also a runner-up in the L'Oréal-UNESCO for Women in Science Fellowship (2019).



Postgraduates **TAN Chia Jie** (left) and **TOH Yi Long** (right) won awards for their research at the XVIII International Symposium of Oncology Pharmacy Practice in October 2019.

COVID-19 RESEARCH

Establishing viral genome sequencing capability



Prof **October SESSIONS** partnered with researchers at Tan Tock Seng Hospital (TTSH), the Genome Institute of Singapore, the Agency for Science, Technology and Research (A*STAR) and the Bioinformatics Institute (A*STAR) to establish full viral genome sequencing capability at the TTSH Microbiology Laboratory. This is achieved by using the handheld Oxford Nanopore sequencer. The genomic data from this effort will be added to a central database to assist national contact tracing.



Measuring impact of public outreach

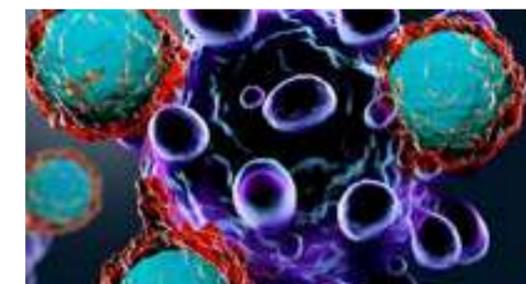


Prof **WEE Hwee Lin** found that the extent to which public health authorities in Singapore, the United States of America and England made use of their Facebook pages for public outreach mirrored their respective approaches to pandemic management. The study shows that timely and multithemed dissemination of health information helps in improving public response. In Singapore, public sentiments of content posted by the Ministry of Health improved as the pandemic evolves.

RESEARCH ACHIEVEMENTS

The next frontier in cancer treatment

Prof **Gloryn Chia**'s research aims to identify current gaps in cancer vaccine development. She harnesses new genomic technologies to improve the efficacy of neoantigen vaccines, with the ultimate aim of translating the research findings into clinical practice and personalising cancer treatment.



Next-generation peptides for infectious diseases

Prof **Brandon I. MORINAKA** and his team have identified a collection of post-translational modifying enzymes in bacteria that catalyses macrocyclisation via carbon-carbon (C-C) bond formation through a bridging aromatic ring to form strained cyclophanes. This research provides the foundation for studying the chemistry and biology of an intriguing new family of peptide natural products that may lead to therapeutics against infectious diseases. This work was published in *Nature Chemistry* (August 2020).



KEY EVENTS



Anniversary celebrations

We held a year-end dinner on 7 December 2019 to celebrate the anniversary of the Pharm.D. programme with our alumni, faculty and friends. In addition, a three-part "Last Lecture" series was organised in conjunction with the Faculty's 90th anniversary. To celebrate NUS Pharmacy's 115th anniversary, three #PassionPridePurpose contests were also organised for alumni and students.

DEPARTMENT OF PHYSICS

EXECUTIVE SUMMARY

The Department of Physics continually increases our suite of academic offerings to provide our students breadth and depth of educational training. Our faculty members continue to conduct collaborative, multidisciplinary research in frontier areas, like quantum information technology, and optical and magnetic materials. Amidst COVID-19 restrictions, we introduced novel online engagement initiatives to bring science education to youths.

EDUCATIONAL MILESTONES



We launched a module on Machine Learning (ML) for Physicists, which covers ML models, their underlying principles, and foundational statistics and information theory. The practical knowledge gained helps students to incorporate ML tools into research, and opens doors to careers in research and quantitative fields.



Prof SOW Chong Haur
Head

AWARDS AND ACCOLADES



Prof **Artur EKERT**, a quantum cryptography pioneer, is one of 19 top scientists worldwide honoured as a Citation Laureate (2019) by the Web of Science Group. This accolade celebrates highly cited researchers with transformative contributions to science.

Prof **LOH Huanqian** was named among "15 Rising Talents" worldwide by the UNESCO and L'Oreal Foundation's For Women in Science programme (2020) for the physical and engineering sciences for her research on quantum simulation (pg 25).



Prof **Shaffique ADAM** was awarded the National Research Foundation (NRF) Investigatorship (2020), which supports selected scientists who are recognised leaders in their fields, to pursue groundbreaking research (pg 26).

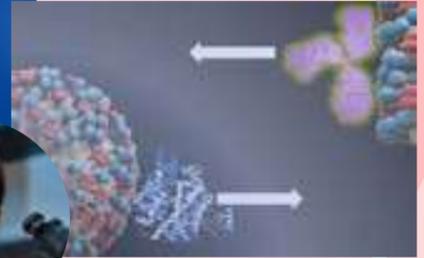
Prof **Yvonne GAO** received an NRF Fellowship (2020) for her work in quantum circuits (pg 26).



COVID-19 RESEARCH

Portable test kit for onsite detection

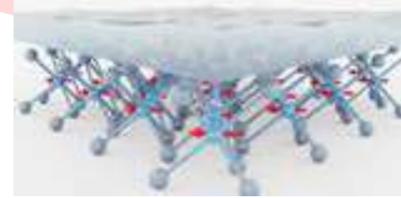
Prof **YAN Jie**'s team has developed portable testing kits for the SARS-CoV-2 virus for rapid, low-cost testing with high sensitivity and specificity. Experimental prototypes developed in the laboratory show that the test outcomes can be made available within 30 minutes when applied with a mechanical force to the interacting biomolecules. The test kit detects the lifetime difference between specific and non-specific biomolecular interactions, and applies mechanical force at the molecular level to enhance its detection specificity.



RESEARCH ACHIEVEMENTS

An electrical switch for magnetism

Semiconductors are the heart of information-processing technologies, while magnetic materials are essential for information storage devices. Magnetic semiconductors are a unique class of materials that allow control of both the electrical charge and spin, potentially enabling information processing and memory operations in a single platform. Prof **Goki EDA**, together with Prof Hidekazu KUREBAYASHI, University College London, have demonstrated the control of magnetism in a magnetic semiconductor via electrical means, paving the way for novel spintronic devices. This work was published in *Nature Electronics* (June 2020).



Interfacial interactions stabilise quantum phase in 2D material

Quantum mechanics tell us that all particles behave as waves. This wave nature is particularly evident for particles with very small masses, such as electrons. Using quantum mechanical calculations, Prof **QUEK Su Ying**'s team demonstrated that the charge density wave phase in H-phase tantalum disulfide (TaS_2) bilayers can be stabilised at room temperature by interfacial interactions with a hexagonal boron nitride (*h*-BN) substrate, holding potential for room temperature applications of these systems. This work was published in *American Chemical Society Nano* (February 2020).



Catalysts speed up reactions by changing their shape

Catalysts can change their structure in different environmental conditions. However, current analytical tools are unable to realistically capture these changes. Prof **Utkur MIRSAIDOV** imaged the structural changes in noble metal catalysts during carbon monoxide oxidation, showing that catalysts switch between inactive and active states depending on the reaction temperature. These observations of reversible transformations in catalysts have important implications for the development of high performance catalysts for a wide range of industrial processes. This work was published in *Nature Communications* (May 2020).



Advancing quantum technology capabilities

Prof **José Ignacio LATORRE**, a leading scientist in particle physics and quantum information, was appointed Director of the Centre for Quantum Technologies (CQT) in July. He previously led a research group building Spain's first quantum processor.

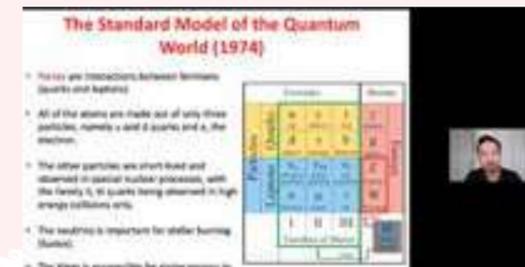
An international team led by CQT researchers has shown that data from the nanosatellite, SpooQy-1, creates entangled quantum signals in a compact instrument onboard. In the future, nanosatellites might be capable of building a global quantum internet that transmits quantum signals to receivers on Earth or on other spacecraft. These signals could also be used to implement various quantum communication applications.



Image credit: National Aeronautics and Space Administration (NASA)

Image credit: CQT

KEY EVENTS



Online outreach

We rolled out a series of online videos to engage students and the general public in exciting science topics. The series featured thematic e-lectures by Profs **SOW Chong Haur**, **Andrew WEE**, **TAN Meng Chwan** (left) and **LOH Huanqian** covering topics such as string theory, quantum physics and nanomaterials, with more in store. Viewers also learnt and visualised physics concepts through interactive live demonstrations. The lectures were well-received and continue to be hosted online (pg 11).

DEPARTMENT OF STATISTICS AND APPLIED PROBABILITY

EXECUTIVE SUMMARY

The Department of Statistics and Applied Probability introduced two sense-making modules, which provide final year students real-world exposure. Our faculty members serve on the editorial boards of top statistical journals, and continue to secure prestigious research fellowships. We also stepped up efforts to engage our alumni.

EDUCATIONAL MILESTONES

Our first cohort of Data Science and Analytics (DSA) students graduated this year, equipped with the knowledge and skills to develop novel analytical tools for new scientific applications and industry problems of the future (pg 7).

We continue to refresh our DSA programme for industry relevance. Our final year DSA students can now read sense-making case analysis modules such as DSA4261, which focuses on logistics and transport and DSA4262, which focuses on health and medicine. These modules enable them to gain practical industry experience and build connections with career professionals.

We collaborated with various organisations - international classification company DNV-GL and technology company rise-x.io on DSA4261; the Agency for Science, Technology and Research (A*STAR) and Singapore Health Services (SingHealth) on DSA4262 - to design projects simulating real-world business scenarios that require students to devise solutions. We also invited market research company Kantar Group to organise mini-hackathons for students in the data science in practice module.

RESEARCH ACHIEVEMENTS

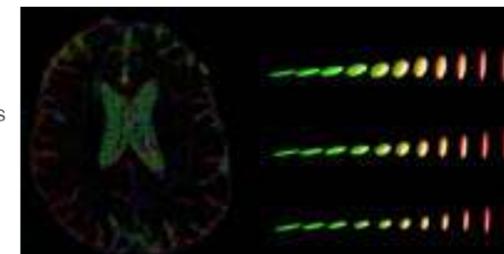
Quantifying regional pollution characteristics

Air pollution is a public health concern in many countries, including China. Prof **ZHOU Wang** and his team collected daily PM2.5 data of five cities in China - Beijing, Tianjin, Jinan, Tangshan and Qinhuangdao - from 1 January to 31 December 2017. They developed a new statistical test to analyse the regional relationships of PM2.5, a measure of the main pollutant, in these cities. They formally introduced the concepts of high order conditional distance covariance, and joint high order conditional distance covariance to test conditional independence. Their research findings were published in *Probability in the Engineering and Informational Sciences* (July 2020).



Studying brain dynamics with a new statistical framework

Prof **LIN Zhenhua**'s work lays the mathematical and statistical foundation for intrinsic analysis of time-varying nonlinear data. It has important applications in neuroscience, especially studies on dynamic brain connectivity and integrity of white matter tracts, and their relation to brain diseases such as Alzheimer's. This work was published in *The Annals of Statistics* (December 2019). Another work, published in the *SIAM Journal on Matrix Analysis and Applications* (November 2019), provides a sound framework for analysing symmetric positive-definite matrices that are commonly encountered in medical imaging.



When should we combine data?

In our increasingly data-driven society, datasets and our models for them often reflect a hierarchical structure. One example would be a measure of educational attainment of students in classes and schools. Large hierarchically structured datasets presents several concerns, including combining information across small groups in relevant ways. If data quality is poor, or prior information built into the model is unreliable, then combining conflicting information can do more harm than good. Recent work by Prof **David NOTT** and his co-authors published in *Statistical Science* (June 2020) discusses new methods to check for such conflicts.

KEY INITIATIVES

Supporting our Class of 2020

Amidst a weak job market brought about by COVID-19, we actively sought to render assistance to our fresh graduates. Thanks to our alumni, we secured the support of various companies, including Next Evo X, MC EduTech, DBS Bank and NUS Centre for Behavioural Economics, to hire our graduates under the SGUnited Traineeships scheme.



Industry sharing

The Data Analytics Consulting Centre (DACC) partnered with Kantar Group, SingHealth and DBS Bank to organise industry sharing sessions. These sessions were attended by over 100 students who learnt more about these industries and the career opportunities they offer.

DACC also offered four Research Associate trainees the opportunity to acquire data science skills in areas like deep learning, Machine Learning, and Python and R programming through consulting projects. These include projects by the Singapore Tourism Board to design and develop codes and processes using deep learning techniques, and by Thome Singapore Holdings Pte Ltd to develop an algorithm for risk profiling of vessels in the fleet, based on a combination of structured and unstructured data.



Prof
CHAN Hock Peng
Head



AWARDS AND ACCOLADES

Prof **LI Jialiang** was elected Fellow of the American Statistical Association for his outstanding contributions to statistical methodology on personalised medicine and diagnostic medicine (pg 25).



LEE KONG CHIAN NATURAL HISTORY MUSEUM

EXECUTIVE SUMMARY

The Lee Kong Chian Natural History Museum (LKCNHM) is a leader in Southeast Asian biodiversity research and education, and home to one of the most important natural history collections from the region. Besides expanding our collections, we have continued to build capacity in research, outreach and education, including developing digital resources and conducting new public engagement programmes.

EDUCATION

Our staff taught two undergraduate modules in the University Scholars Programme, and two graduate modules in the Department of Biological Sciences, and M.Sc. in Environmental Management programme in addition to conducting guest lectures/talks for other modules and organisations. New modules are also being developed for the coming year, even as the traditional Life Sciences field module is being revamped.

OUTREACH

We introduced a suite of virtual programmes to engage the public during the national circuit breaker caused by COVID-19 as gallery tours and activities took a mandatory break. In May, our education officers organised a three-part chat series with guest experts on various topics which drew over 600 participants online.

Our research staff contributed two webinars for 170 participants, as part of a series of public biodiversity talks. We also conducted over 90 programmes for 5,200 participants from 85 schools and the general public.



We unveiled a statue of the famous British naturalist Alfred Russel WALLACE and his assistant Ali in front of the museum on 30 August 2019, which was launched by Senior Minister and Coordinating Minister for National Security Mr TEO Chee Hean. The statue was designed and sculpted by Nanyang Academy of Fine Arts students, a joint project between our institutions commemorating the Singapore Bicentennial. Correspondingly, a new gallery exhibit highlighting Wallace's regional travels and discoveries was also launched.

Following the Bicentennial exhibition, we released a digital version of the accompanying publication, *200: Points in Singapore's Natural History*.



Prof Peter NG
Head

COVID-19 EFFORTS

The museum's entomologists were asked by the Changi Exhibition Centre (CEC) Community Care and Recovery Facility Committee to help assess the Temp Dorm @ Kranji and Community Recovery Facility next to the CEC for harmful or nuisance insects that could affect the well-being of migrant workers housed there.



Since May, our entomologists conducted trapping surveys around the recovery facilities. Collected insects were sorted and identified in our research laboratories to check for disease-transmitting vectors, insects that can damage infrastructure or other swarming nuisance insects.

Based on the field surveys and laboratory work, our staff proposed mitigation measures, such as the installation of decoy floodlights to draw away swarming insects that might otherwise enter tentage housing the patients. They also recommended the type of light that deters light-seeking insects, for use within the facilities.



RESEARCH



A core mission of the museum is biodiversity exploration and discovery through regional/international expeditions. This year saw two major expeditions to Sarawak under a Memorandum of Understanding with the Sarawak Forestry Corporation. Staff also explored farther afield, participating in a deep-sea expedition to the Clarion Clipperton Zone in the eastern Pacific organised by Keppel Corporation and NUS' Tropical Marine Science Institute.



We hosted 47 visiting scientists from 21 countries who conducted research on our collections, many in collaboration with museum staff. Additionally, 104 specimens were sent to 22 institutes in 15 countries as research loans. Conversely, the museum acquired 52 lots from Singapore and Southeast Asia.

Museum staff produced 72 publications, including 54 peer-reviewed papers (44 in journals listed in the *Web of Science*) and two books in systematics and taxonomy. Some 50 new species were described, mostly from Southeast Asia, but included some from as far away as Hawaii, India, Madagascar, Papua New Guinea and Vanuatu. Of note were seven new species, among them the giant isopod, *Bathynomus raksasa*, described from the South Java Deep-Sea Biodiversity Expedition of 2018.



FACTS AND FIGURES

UNDERGRADUATES

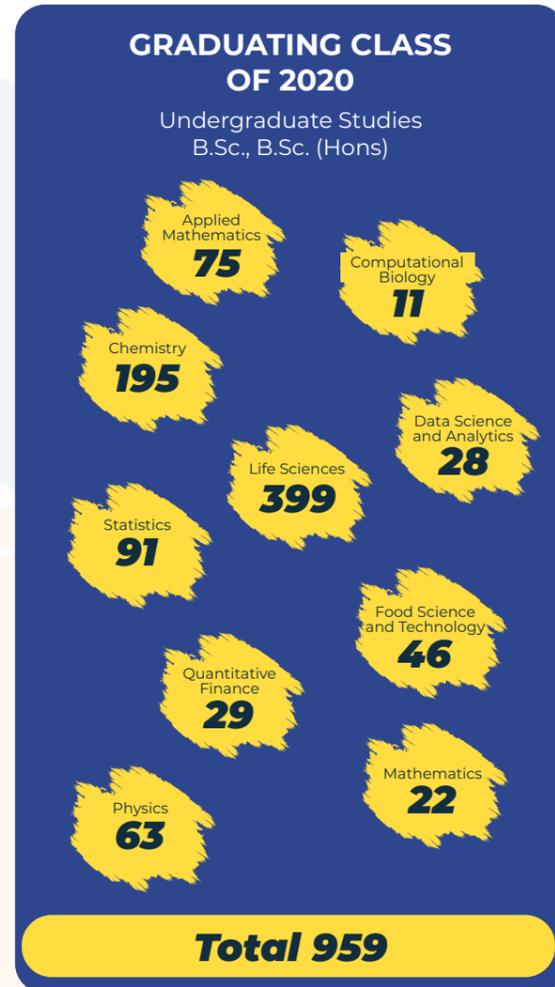


4,363 Undergraduate students

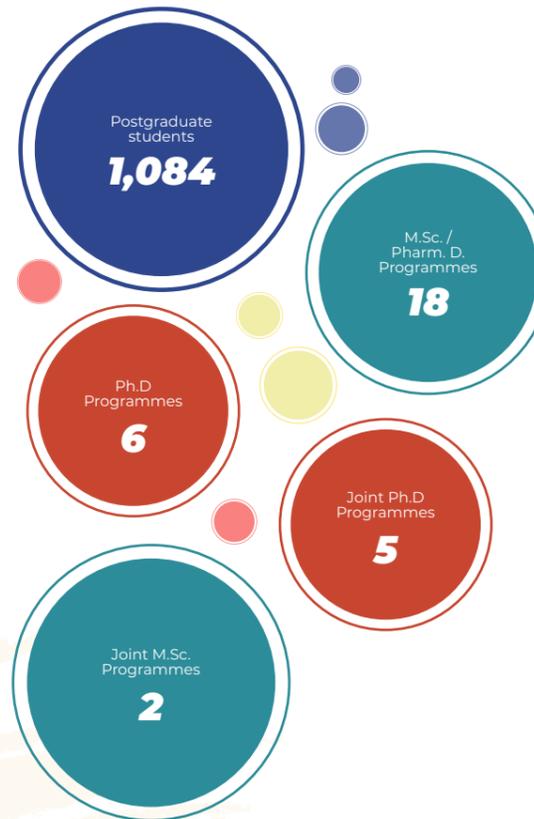
- 13** Majors*
- 13** Specialisations
- 7** Second Majors
- 16** Minors
- 2** Structured Double Degree Programmes
- 3** Joint Degree Programmes
- 2** Concurrent Degree Programmes
- 6** French Double Degree Programmes**

* Includes Environmental Studies which is jointly hosted with the Faculty of Arts and Social Sciences

** Refers to B.Sc. (Hons) and M.Sc. from NUS and Diplôme d'Ingénieur from French Grandes Écoles



POSTGRADUATES



GRADUATING CLASS OF 2020

Graduate Coursework Programmes

16 M.Sc. in Applied Physics	20 M.Sc. in Chemistry	28 M.Sc. in Chemistry for Energy and Environment	34 M.Sc. in Food Science and Human Nutrition
13 M.Sc. in Industrial Chemistry	18 M.Sc. in Mathematics	9 M.Sc. in Pharmaceutical Science and Technology	6 M.Sc. in Physics
58 M.Sc. in Quantitative Finance	10 M.Sc. in Science Communication	140 M.Sc. in Statistics	7 Doctor of Pharmacy

Graduate Research Programmes

37 Ph.D Biological Sciences	13 M.Sc. Chemistry	27 Ph.D Chemistry	5 M.Sc. Food Science and Technology	3 Ph.D Statistics and Applied Probability	4 M.Sc. Statistics and Applied Probability
11 Ph.D Mathematics	4 M.Sc. Pharmacy	8 Ph.D Physics	16 Ph.D Physics	7 M.Sc. Physics	6 Ph.D Statistics and Applied Probability

RESEARCH OUTPUT AND RECOGNITION



- | | |
|---|---|
| Asia - First[^]
Chemistry
Mathematics
Pharmacy and Pharmacology
Statistics and Operational Research | Global - Top Twenty[^]
Biological Sciences
Chemistry
Environmental Sciences
Materials Science [#]
Mathematics
Pharmacy and Pharmacology
Statistics and Operational Research |
|---|---|

[^] Research subject ranking
Source: QS World University Rankings by Subject (2020)
[#] Includes contributions from materials physics and materials chemistry

SKILLSFUTURE SINGAPORE (SSG) FUNDED COURSES/PROGRAMMES



* Includes graduates from Applied Mathematics-Computer Science, Computational Biology-Economics, Life Sciences-Economics, Life Sciences-Psychology, Mathematics-Computer Science, Mathematics-Philosophy, Physics-Philosophy, Statistics-Economics

