YOUR SG GUIDE TO
RESEARCH, INNOVATION AND ENTERPRISE

RIE NEWS

July 2019

FUSING GREENERY AND GOOD DESIGN

1 NATIONAL DRUG DEVELOPMENT CENTRE FORMED TO DEVELOP NEW MEDICINES HERE

Drug development in Singapore is given a boost with the formation of the Experimental Drug Development Centre. Researchers from A*STAR research institutes, hospitals, universities and companies can work together at the national drug discovery and development platform to translate research discoveries into new medicines. Drug development efforts in Singapore has led to two home-grown drug candidates – ETC-206 and ETC-159. ETC-206 is a drug candidate targeted at blood cancers, while ETC-159 targets a range of cancers including colorectal, ovarian and pancreatic cancers.

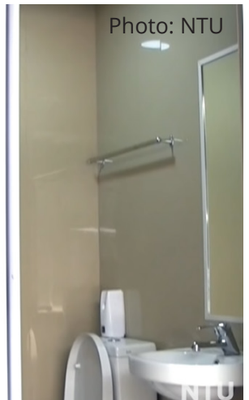


Photo: NTU

Photo: Rehabilitation glove developed by Roceso Technologies

2 COMPANIES AND RESEARCHERS GATHER TO DEVELOP HEALTHCARE PRODUCTS

NRF has set up a consortium to bring researchers and companies together to leverage technologies to develop advanced health and wellness products that will benefit Singaporeans. The Health Technologies Consortium welcomes companies to work with researchers on health sensing technologies, as well as health analytics and artificial intelligence. Companies that join the consortium can access research from universities and research institutions for development into healthcare products. Roceso Technologies, a startup that specialises in soft robotic exoskeleton technologies for rehabilitation, is among the first group of companies that have joined the consortium.

3 3D-PRINTED BATHROOMS

With 3D-printing, you can "print" an unfurnished bathroom from scratch within a day. NTU and Sembcorp have successfully used 3D printing to build prefabricated bathrooms about 30 per cent faster than current methods. The innovation is an output of NTU's Singapore Centre for 3D Printing, set up to conduct research and development on 3D printing technology, and to accelerate the adoption of the technology by companies.

4 NEW BLOOD TEST FOR ALZHEIMER'S DISEASE

It may not be long before doctors can detect Alzheimer's Disease through a simple blood test. NUS researchers have developed an Amplified Plasmonic Exosome (APEX) system that can diagnose the disease even before clinical symptoms appear. The technology's accuracy is comparable to PET imaging, the current gold standard for Alzheimer's Disease diagnosis, and costs about $30 per test, which is less than 1 per cent of the cost of PET imaging.

5 FIRST WASTE-TO-ENERGY PLANT OPENS IN SINGAPORE

NTU and NEA have introduced a first-of-its-kind facility in Tuas South that converts waste from the NTU campus into electricity and resources. The Waste-to-Energy plant heats up waste and turns them into slag, which can be used for construction, and metal alloy granulates, which can be recycled. Syngas, another by-product of the process, is heated to generate steam for driving turbines to produce electricity for the plant.

INTERVIEW

GOING GREEN IN STYLE

FUSING GREENERY AND GOOD DESIGN INTO SINGAPORE'S URBAN LANDSCAPE ENHANCES OUR LIVING EXPERIENCES. URBAN GREENERY RESEARCH THRUST LEADER AT THE SCHOOL OF DESIGN AND ENVIRONMENT AT NUS **DR TERRENCE TAN** TELLS US HOW HE IS CONTRIBUTING TO THIS EFFORT

Tell us more about your urban microclimate assessment method. How does it contribute to sustainable urban development?

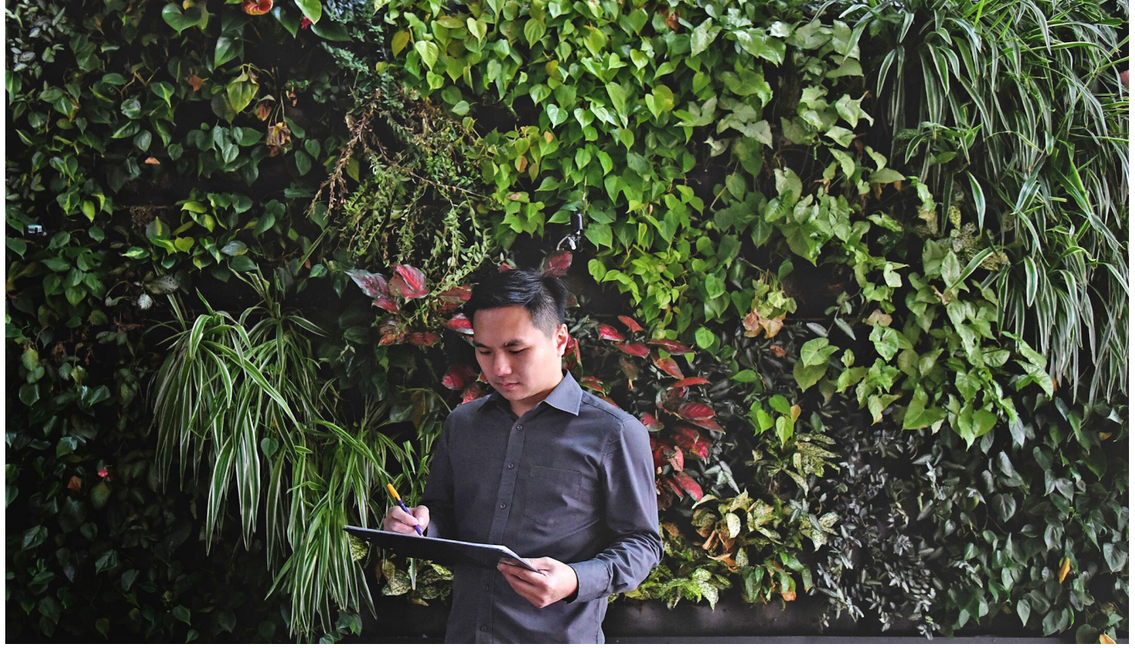
My research focus is on urban greenery systems such as green walls and green roofs. My team is part of a bigger sustainable urban design initiative headed by Professor Wong Nyuk Hien from the School of Design and Environment at NUS.

We are trying to address the issues of climate change and Urban Heat Island effect. This is done through climatic mapping. A climatic map is a site plan with building footprint and landscape information, with added layers of climate data such as ambient temperature or wind speed and direction. The climatic map enables scientists to inform designers of the impact of their design schemes to the environment in a manner that is easily understood. Climatic maps can be generated via fieldwork or computer simulation.

By understanding the local microclimate, we hope to identify what drives good design and develop guidelines for designing sustainable urban landscapes.

You are involved in the experiment to install plants on bus roofs, to cool bus interiors and possibly also lower outdoor temperatures. Tell us more about your experience working on greening building roofs in urban cities, and what kind of result you expect for the bus roof project.

I have been conducting Urban Heat Island research since 2010. My focus into urban greenery started some years ago when it became clear that having greenery was an effective means of reducing temperature in the built environment. The problem was that most research looked into parks and trees, and studies into systems such as green walls and green roofs were still relatively in their infancy.



Dr Terrence Tan in front of a green wall. Green walls and roofs are key components of urban greenery systems. Photo: Dr Terrence Tan

Our own studies have shown that surface temperature on building surfaces can be reduced dramatically in the presence of green walls and green roofs. I am interested to see if the same is true for greenery on buses.

What has been your most surprising finding on the effects of greenery on temperatures in urban cities?

My most surprising finding is that not all greenery is effective at reducing temperature. Due to certain plant functional traits, some plants are better at cooling than others. This is perhaps the most important point, as it sets the basis of my Landscape Design Optimisation framework. Through this framework, we systematically identify areas of buildings or precincts that are vulnerable to heat gain and assign plants that can provide better cooling to these areas.

What are the upcoming developments in greening urban cities that you think would be the most significant?

Personally, I feel that greening urban cities to ensure our food security may be one of the more significant research topics in recent years. This is a pressing issue, in view of our current reliance on food imports. My opinion is that we are only starting to tap on the power of the masses when it comes to urban agriculture.

Dr Terrence Tan imparts knowledge on urban greenery to primary school students through activity-based workshops. Photo: Dr Terrence Tan

Do individual efforts in growing small plants contribute to urban green spaces?

One of the many benefits of plants is that they contribute to mental well-being. So yes, they do help in this way. It is good to have plants around you, but please remember to water them regularly.

Incidentally, we are commencing a study on greenery and mental well-being. In this study, we will measure brain activity and stress levels of participants after experiencing greenery in different forms. Our hypothesis is that the presence of greenery can promote mental well-being and improve workplace efficiency.

What is one experiment that you have done that you wish more people would ask you about?

The one project that I would like to talk about is not so much an experiment but a series of urban greenery workshops I have initiated since 2016. I was exploring means of disseminating knowledge on urban greenery using architectural models to primary and secondary school students in Singapore. I had some training in architecture (NUS) and wanted to incorporate the design process into the workshop curriculum. To my surprise, I have found that students respond really well to the workshop activities and I hope it can be developed into a curriculum that can be used to teach topics in Mathematics and Science. I design my own games for the students to engage in city planning and building design exercises. Some photos taken from the workshops can be found on my website. My dream is for every school to have an Urban Green Lab.

What do you like best about your research?

Perhaps the best thing about my research is that I am constantly learning new things about greenery. With this new knowledge, I get to see the same landscape with a different pair of lenses and more importantly, a renewed sense of wonder. It really helps in keeping boredom at bay.

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My aim is to break the rigid dichotomy between academia and industry practice by presenting findings from my research in a manner that is easily understood and actionable by those in the industry.

What drives your passion to discover ways to reduce temperature in urban spaces?

If I may, this desire is borne out of a passion for design. I sincerely believe that through the understanding of plants and their benefits, it is possible to infuse these elements into our planning ethos and create a new design paradigm that is truly unique to our tropical urban environment.

What valuable lessons did your research in this area teach you?

Besides conducting research, we often have the added task of communicating our findings to practitioners in an effective way. My aim is to break the rigid dichotomy between academia and industry practice by presenting findings from my research in a manner that is easily understood and actionable by those in the industry. I have found that there are many opportunities to come up with creative solutions here.

Among other things, I have cultivated a deep respect for Mother Nature. When conducting field work, we really are at the mercy of the elements. In 2014, we spent six months setting up an experiment only to have it blown to bits by 100 km/h winds. If there is a lesson to be learnt here, it must be that her wrath was grossly underestimated. Also, extra anchors for the sensors wouldn't hurt.

I would also add that as someone who has been keeping track of the local climate for a few years, it is indeed true that the climate is changing. Increased anthropogenic activity has only served to exacerbate the situation. We ought to do something about it before it's too late.

COMMENTARY

IMPROVING EDUCATIONAL OUTCOMES THROUGH SLEEP

SLEEP RESEARCHER **PROFESSOR MICHAEL CHEE** TELLS US ABOUT THE SLEEPING HABITS OF SINGAPORE YOUTH AND THE ROLE NAPPING PLAYS IN IMPROVING SLEEP DEFICITS

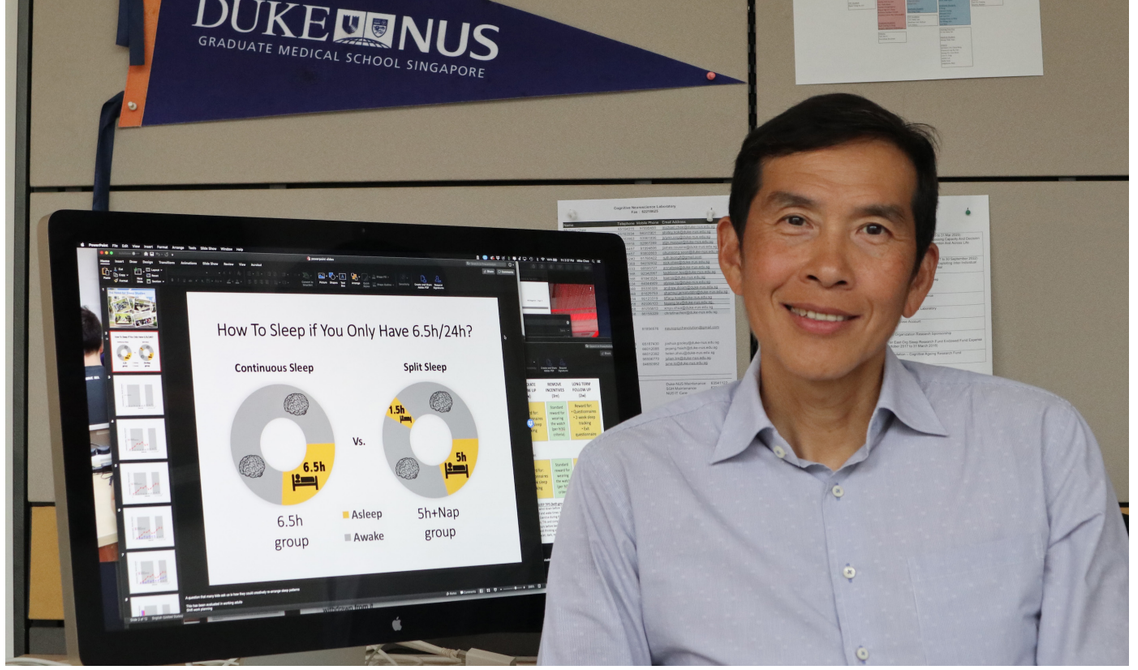
On weekdays, secondary school students in Singapore spend an average of 9.4 hours daily in class or studying. Another one third of those hours are spent on tuition. On weekends, an average of 4.5 hours is spent studying or being tutored.

This leaves our youth with less than an hour a day for physical activities and only about 6.5 hours for bedtime. This amount of bedtime is lower than the 8 to 10 hours of sleep recommended for this age group (7 hours is possibly sufficient). Such time allocation may come at the expense of health, well-being and more rounded social development.

Taking the road less travelled, Dr Joshua Gooley, Dr June Lo and myself have been working on optimising sleep time to improve student outcomes in a sustainable manner. We reason that to date, efforts to improve education outcomes have exclusively focused on measures enacted during wakefulness and that by turning our focus on the remaining third of our lives, we will create impact in a part of the world where sleep is shortened by 30 minutes to an hour everyday across the lifespan.

In our "Need for Sleep" series of studies on students aged 15 to 19 years old, we found that although students report spending an average of 6.5 hours in bed on weekday nights, this isn't sustainable if involuntary brief naps (such on the way to school or home) or dozing off in class are curtailed under quasi-laboratory conditions.

Even scholastically strong students show cumulative declines in sustained attention over successive nights of 6.5 hours of nocturnal sleep opportunity compared to students given 9 hours a night in bed.



Professor Michael Chee of Duke-NUS Medical School is the Principal Investigator of a team comprising Associate Professors Joshua Gooley and Helen Zhou, as well as Assistant Professors June Lo and Julian Lim. The team is seeking to optimise learning by improving adolescents' sleep. Photo: Professor Michael Chee

Vigilance decline was compounded following a second exposure to the same schedule after a simulated weekend during which the sleep restricted group were given 9 hours to sleep at night. Alongside vigilance, speed of processing and working memory also declined, albeit not as robustly. We also confirmed what many educators and parents know: sleep-restricted adolescents exhibit consistently worse positive mood.

Can napping help? We found that if one only had 6.5 hours to sleep over 24 hours, a 1.5 hours mid-afternoon siesta coupled to 5 hours of night time sleep opportunity was helpful for restoring vigilance, boosting memory encoding and fact learning, compared to if the total amount of sleep was taken exclusively at night.

Even though these naps are considered long, under such conditions of sleep restriction, they did not interfere with nocturnal sleep. If anything, splitting slow wave sleep into two sections may have improved cognitive outcomes. Further, the nap benefit extended into the evening and even had some influence on performance in the mornings as the effects of successive nights of sleep restriction accumulated.

Students performing standardised test batteries at a "Need for Sleep" study. The electrodes worn by the students were used to record sleep architecture during their mid-afternoon naps. Photo: Professor Michael Chee

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Even scholastically strong students show cumulative declines in sustained attention over successive nights of 6.5 hours of nocturnal sleep opportunity compared to students given 9 hours a night in bed.

In a separate set of studies, postdoctoral fellow Dr James Cousins found that educational material was equally well-recollected when participants either took a nap in between learning or if they spent the time cramming. Both napping and cramming following learning were better during a one-hour post learning test than if students just spent that time watching a movie. However, a week later, only the nap group showed a significant benefit in fact recollection compared to the movie group.

Are naps all good to go? They certainly help with cognitive performance in sleep-restricted teenagers, but it turns out that their benefits have a Faustian bargain attached: under conditions of mild sleep restriction, splitting sleep resulted in poorer glucose tolerance compared to continuous nocturnal sleep. Conceptually, sleep scientists have speculated that optimal sleep duration may differ for different health goals. This is the first study providing empirical evidence for that intuition.

What about shorter duration naps coupled with more adequate nocturnal sleep? Would 10, 15 or 30 minutes suffice? The benefit of these shorter naps popularly called 'power naps' has been shown in adults, but it is unclear if the duration of the nap benefit extends into the evening in adolescents as was the case for the 60 and 90-minute naps we have tested. Many students we have spoken to told us that they 'nap' in the evening for as long as 1-2 hours. Such habits may interfere with nocturnal sleep and contribute to later bedtimes but again, whether this actually happens remains an open question. These are some follow up studies on napping we seek to pursue in coming months.

In related work, funded through separate channels, we conceived and developed an innovative mixed media, teacher-delivered sleep education programme to a local school that has attracted a partnership with an Oxford University team to compare results and cultural differences in how to approach sleep education. We have also demonstrated that starting secondary school 45 minutes later than 7:30 AM has sustained benefits on lengthening sleep duration, reducing sleepiness and improving subjective wellbeing in students who are first briefed on how good sleep can benefit them.

Perhaps the largest opportunity ahead of us is to use smartphone and wearables to help us determine at an individual level, how best to sleep. The first step of this journey has been taken with Fitbit, a leading manufacturer of activity and sleep tracking wearables. We recently found that their consumer wearables provide information about adolescent sleep of comparable quality relative to a widely-used research actigraph at its default settings.

This paves the way for large-scale studies. Our dream is to devise methods of integrating sensor data across platforms to monitor behavior and sleep as un-intrusively as possible, so that we can identify sleep patterns that work best for an individual. This will go a long way to optimising not only educational outcomes but health and wellbeing. Stay tuned.

Part of the research described here was funded by the NRF under its Science of Learning Programme, which supports scientific approaches to transform learning in schools.

SPOTLIGHT ON SGINNOVATE

BUILDING A STARTUP THAT THRIVES ON DEEP TECH

SGINNOVATE WORKS WITH SCIENTIST-ENTREPRENEURS TO BUILD AND SCALE THEIR COMPANIES. THIS COLUMN FEATURES THE DEEP TECHNOLOGY STARTUPS THAT IT IS INVESTING IN. WE LOOK AT **AIDA TECHNOLOGIES** IN THIS ISSUE.

AIDA's CEO Dr Tan Geok Leng pitching at the Singapore Fintech Festival in 2016, where the team won the Hackcelerator award. Photo: Dr Tan Geok Leng

Want to build a startup? Here's an advice from Dr Tan Geok Leng: You'll need a strong team with deep technical capabilities, the domain know-how and the right business relationships.

With a strong team in place, your startup will be well-placed to develop solutions and products of superior performance for your target market.

Building a startup is something that Dr Tan, CEO of AIDA Technologies, is familiar with.

He set up AIDA Technologies, which provides solutions for the insurance and banking sectors, just two and a half years ago. But it has already received multiple accolades.

AIDA Technologies won awards at the Singapore FinTech Festival in 2016 and 2017. Last year, it won the National TechBlazer Award 2018. AIDA was also identified as one of the top 25 Most Recommended AI Company 2017 by APAC CIO Outlook Magazine.

In addition, since its founding, AIDA has secured over 20 Tier-1 banking and insurance customers in Singapore, Malaysia, Indonesia, Thailand, Hong Kong and India. In January 2017, it raised a seed round with Kuok Ventures. More recently in April 2019, AIDA closed its Series A round which was led by Mastercard and supported by Kuok Ventures and SGInnovate.

Back in September 2016, Dr Tan founded AIDA Technologies together with a team of data scientists from the Agency for Science, Technology and Research (A*STAR)'s Institute for Infocomm Research (I^2R). Before starting AIDA, he was the Executive Director at I^2R. The goal for AIDA was to develop artificial intelligence (AI) and machine learning solutions for the banking and insurance industries.

AIDA's key competitive advantage lies in its industry-proven capabilities in AI and machine learning technologies arising from their data scientists' research, and real-world experience in the application of such technologies derived from working with industry partners.

Despite their successes, the journey has been an exciting one that is filled with challenges for the company, Dr Tan shares.

For instance, banks and insurance companies are very conservative, and it is an uphill battle to gain their confidence. Fortunately, some were able to recognise the talent and capabilities that AIDA provides.

AIDA's deep AI/ML expertise, coupled with their real-world domain experience, has made all the difference. "Because of our experience, our success rate to secure follow-on discussions with a customer is very high, and when good results can be demonstrated, we have been able to close some large deals," says Dr Tan.

AIDA's advanced AI/ML tools and algorithms can be applied to other verticals such as healthcare, Fast Moving Consumer Goods (FMCG) and transportation. However, as a strategy, Dr Tan shares that AIDA is currently "very focused" on achieving market leadership in the banking and insurance sectors before entering other verticals.

AIDA's CEO Dr Tan Geok Leng (right) and CTO Dr Shonali Krishnaswamy receiving the National TechBlazer Award (Bronze) in 2018. Photo: Dr Tan Geok Leng

In its initial phase, the startup has leveraged its Singapore roots and network to secure customers in Singapore and the ASEAN region. What's next for AIDA then?

There are plans to deepen penetration in existing markets such as Singapore, Malaysia, Thailand, Indonesia and India, and to open up markets in the Philippines and North Asia, especially in Hong Kong and Japan. For the new markets, AIDA will draw on its existing customers' networks and relationships to create the openings by way of direct introductions, thus reducing the barriers to entry.

"We are already making plans to ensure that we have the organisational structure to rapidly deliver products and solutions, and to ramp up our sales and marketing network in the targeted markets," Dr Tan says.

For now, the startup has set its sights on becoming a key player in AI/ML for the banking and insurance sector for the region and then, the world.

AIDA Technologies is one of SGInnovate's portfolio companies. SGI first invested in AIDA in 2018. In April 2019, SGInnovate participated in their Series A round of funding.

What AIDA offers

AIDA's solutions for the insurance sector include automation of the health insurance claims process, and detection of outlier/fraud in health insurance claims. AIDA's outlier engine and proprietary drift detection engine can be used to detect "unknown unknowns", which are fraud mechanisms that may remain undetected for a long time. The same outlier engine has also been applied to detect "Insurance Agent Misconduct scenarios" for a large regional insurance company.

For the banking sector, AIDA's solutions include an end-to-end SMART Lending system, which is able to identify which customers may become bad and thus churn or become a non-performing-loan. It can identify customers with a propensity to buy additional products such as credit cards, bank loans, insurance products such as auto or home insurance. AIDA is also able to credit-score customers that are "new to bank" and identify sweet spots to conduct marketing campaigns to bring in new customers to the bank.

AIDA's Know-Your-Trader (KYT) Risk Management Platform is able to analyse transactions (structured) and communications (unstructured) in a way that has never been done before. The novelty of AIDA's KYT Platform was recognised by judges at the Singapore FinTech Festival 2016, when it won the Hackcelerator award. Currently, the KYT Platform is being deployed at a Tier-1 bank in Malaysia and Singapore.

Up close with Dr Tan Geok Leng

If you could go back in time and give yourself a piece of advice at the start of your career, what would it be?

1. Build a T-shaped capability – A deep technical know-how in a specific area and broad capabilities gives you an understanding of what is happening across the industry landscape. You need to maintain an interest to know where technology and industry is heading, and yet personally have deep technical skills in an area of relevance, that lets you stand apart from everyone else.

2. Network extensively – and, if necessary, change jobs. Each time you change your job, you are learning new ideas and skills in areas such as organisation structure, technologies, and markets. Equally important, you are building new people networks. All these are intangible know-how which can help you later in your career.

INTERVIEW

BAT REVELATION

PROFESSOR KOJI ITAHANA FROM THE DUKE-NUS CANCER AND STEM CELL BIOLOGY PROGRAMME TELLS US ABOUT A NEW STUDY REVEALING THAT A PROTEIN PRESENT IN HIGHER AMOUNTS IN BATS – COMPARED TO HUMANS – MAY CONTRIBUTE TO THEIR LOW CANCER INCIDENCE

What have we discovered in bats?

Bats are unique mammals with the ability to fly and live up to 40 years old. They also have a low incidence of cancer. How bats evolved to have such advantageous features is still largely unknown. Recently, we discovered that bat cells accumulate less toxic chemicals than human cells by moving these substances out of the cells. The underlying mechanism is the cell surface pump protein, ABCB1, which is highly abundant and broadly distributed in bat tissues whereas it is expressed in limited organs in humans. The protein prevents prolonged exposure to harmful chemicals, thereby protecting the DNA of bats from becoming damaged and mutated.

We found that high expression of ABCB1 is conserved across many species of bats. Based on our findings, we propose that the ABCB1 protein is a potential contributing factor to the low incidence of cancer in bats.

Can you tell us more about ABCB1 and its function?

ABCB1 is a cell surface pump protein commonly found in tissues of the intestinal gut, liver, kidney, and brain of humans. Historically, ABCB1 was mainly identified to protect our body and vital organs by preventing the accumulation of toxic chemicals. It does so by actively exporting the chemicals out of the cells. Accumulation and prolonged exposure to such chemicals can lead to DNA damage, and eventually organ injury or cancer development.

To date, there are over 300 chemicals recorded to be exported by ABCB1 including genotoxic drugs from the environment and synthetic anti-cancer, anti-viral, and anti-depression drugs. It is very interesting that unlike humans, bats express ABCB1 protein highly and broadly. We believe that there might be natural harmful metabolites uniquely generated in bat cells. Removing these metabolites in addition to environmental toxic compounds might support longevity and prevent cancer in bats.

ABCB1 is a potential factor contributing to the low incidence of cancer in bats.

How is ABCB1 connected to cancer treatment?

Cancer is a complex disease caused by mutations in our DNA that lead to abnormal, uncontrolled cell growth. Acquisition of such cancerous mutations is well-correlated with hereditary factors and exposure to certain environmental factors. In the ageing population of Singapore, cancer is becoming more prevalent, with an estimated one in every four or five Singaporeans being susceptible to the disease. Current chemotherapeutic drug treatments are effective in suppressing certain cancer types. However, long-term treatments without complete clearance of the disease can and often lead to the development of chemotherapeutic resistance, resulting in a relapse of cancer.

One of the renowned mechanisms for chemotherapeutic resistance is the ability of cancers to pump anti-cancer drugs out of the cells. This is frequently achieved via the high expression of ABCB1 on the surface of cancer cells. This reduces the accumulation of anti-cancer drugs in the cancer cells, which renders the treatment ineffective. Currently, several synthetic inhibitors of ABCB1 are available for research purpose with good efficacy and long drug half-life. However, they are not clinically approved for patient use mainly due to their intolerable side-effects. Most current ABCB1 inhibitors are ABCB1 substrates that competitively inhibit the ABCB1 transporter. Identifying naturally existing ABCB1 substrates in bats may lead to the development of less toxic inhibitors of ABCB1 against human cancers.

How can we translate this bat-related discovery to fight human cancers?

Cancers expressing the ABCB1 protein greatly reduce the effectiveness of many front line anti-cancer drug treatments. Additionally, without potent and tolerable inhibitors for ABCB1, strategies to tackle such cancers are severely limited. Novel inhibitors of ABCB1 developed from natural ABCB1 substrates in bats could revolutionise chemotherapy and dramatically improve treatment outcomes.

Recent evidence suggests that long-lived mammals take unique strategies to prevent cancer and support their longevity. Although the biology of bats and humans are very different, we found that ABCB1 in bats and humans are approximately 90% genetically identical and conserved across the two species for its functions. It is quite possible that high and broad expression of ABCB1 protein in bats has evolved to support the low incidence of cancer and longevity in bats. Identifying metabolites uniquely generated and exported by ABCB1 in bats and controlling the amounts of these metabolites in humans might help to reduce cancer incidence and ageing in humans.

INTERVIEW

SUPERB FISH GENES

TEMASEK LIFE SCIENCES LABORATORY CONDUCTS FISH GENETICS R&D FOR SUPERIOR TRAITS SUCH AS FASTER GROWTH, TASTINESS, AND BETTER ADAPTABILITY TO SEAWATER. RESEARCH INVESTIGATOR **DR LIEW WOEI CHANG** TALKS ABOUT THE JOURNEY

Temasek Life Sciences Laboratory had chosen Tilapia as the species to conduct genetics R&D for traits such as faster growth, tastiness, and better adaptability to seawater. Why was Tilapia chosen for the research?

At Temasek Life Sciences Laboratory, we are working to improve two aquaculture species – Asian seabass and Mozambique tilapia – by selective breeding.

Tilapia is an important aquaculture species. According to the Food and Agriculture Organization of the United Nations, the global production of tilapia has steadily increased over the last decade and is currently the second most farmed fish in the world. This points to an increased demand for tilapia worldwide. In addition, its unique characteristic of being highly adaptable to a wide range of environmental conditions makes it an ideal candidate for farming in Singapore's coastal waters.

A Tilapia cultured by Temasek Life Sciences Laboratory. Photo: Dr Liew Woei Chang

Ultimately, we aim to develop a line of tilapia that is suitable for culture in seawater by selective breeding. We decided to work on the Mozambique tilapia *(Oreochromis mossambicus)* because it is known to have high salinity tolerance as compared to other tilapia species. This makes the Mozambique tilapia a suitable tilapia species to be cultured in Singapore, as most fish farms in Singapore are floating coastal farms without freshwater source.

Temasek Life Sciences Laboratory's tilapia facility at Sembawang. Photo: Dr Liew Woei Chang

What spurred you to take on research in fish genetics?

I was intrigued by the publication of the first draft of the human genome and chose to do my undergraduate training in molecular genetics. I am also a nature lover and enjoy recreational diving. Therefore, fish genetics to me was like having the best of both worlds, and I seized the opportunity to do an internship with Professor Laszlo Orban in fish genetics at the Temasek Life Sciences Laboratory when the opportunity arose.

What has been your most surprising finding?

Deducing the zebrafish sex determination system and how heat can alter it are two highlights for me. Sex determination for fish is an area that has fascinated me since my postgrad training days. Ray-finned fish form the largest group of extant vertebrates and seem to utilise all the known sex determination mechanisms described for other vertebrates.

To give you an example of the complexity, all three fish species that I work with utilise different mechanisms. The tilapia has the chromosomal sex determination system (such as the XY sex chromosomes), the Asian seabass is a sequential hermaphrodite (it will develop as male first, then changes its sex to female) and the zebrafish has the polygenic sex determination system (whereby sex is determined by multiple loci dispersed throughout the genome).

Besides being an interesting biological question, the ability to control sexual development is important in aquaculture for effective husbandry management, productivity and economics. For tilapia farming, a male-biased population is preferred as males grow faster. This prevents unwanted breeding and

is a form of genetic protection mechanism. The commonly used method for getting male-biased tilapia population is by feeding the fish with the male hormone (17 alpha-methyltestosterone).

What do you like best about your research on breeding superior tilapias?

The best part of my job is the ability to get out of the lab to enjoy the nature and a breath of fresh air. Our tilapia facility is located in a rural area in Sembawang that is away from the hustle and bustle of the city. Occasionally, I also get to travel out to the sea for a visit to the floating farm along the northern coastline of Singapore.

Tell us more about your experience working with farmers to conduct trials on tilapia selection.

We collaborate with local fish farmers to get performance data from our selected tilapia. Many of them have been in the trade for many years and have accumulated a wealth of experience in fish farming. However, this also means that some of them might be reluctant to adopt new technologies or have misconceptions of what we are doing in the selective breeding project.

The most common misunderstanding about our selected tilapia is that it is genetically modified. We have to explain to them that selective breeding does not modify the genome but rather, it is a process of selecting fish with superior traits as brooders. This process is accelerated by using molecular tools (e.g. DNA genotyping) in the lab. Some are reluctant to work with us because we are unable to produce the numbers of fish fry that they want due to space constraint in our research facility. It requires lot of patience and explanation in layman terms to find the right farmer to partner with for a farm trial.

What, in your opinion, is the future of breeding fish with superior genetics?

To meet the growing demand for quality fish protein, genetically enhanced fish is the way forward. However, I think genetics in the future aquaculture is only part of the equation. Fish with superior genetics still require a good culturing environment, balanced nutrition and good health to be able to realise its full potential. Hence, areas such as aquaculture engineering, nutrition and disease management are equally important.

What is your end objective for this project?

Our end objective is to contribute to the sustainability of tilapia culture and food security of Singapore. According to the World Bank Group, sustainable aquaculture consists of three areas: environmental sustainability, economic sustainability, and social and community sustainability.

Tilapia is commonly farmed in freshwater. However, there is a shortage of freshwater sources in Singapore and globally. To achieve environmental sustainability by easing the burden on freshwater sources, we have developed a line of saline-tolerant tilapia that can be cultured in seawater. The saline-tolerant tilapia is further selected for improved growth rate to make culturing them a viable business with good long-term prospect to achieve economic sustainability.

What valuable lessons did your research in this area teach you?

Persistence. Like any research, it is not often that you will get an answer on the first try. Persist in your beliefs and continue to push through in the face of difficulties to seek the answer. In this regard, I quote my mentor Professor Laszlo Orban who said: “Good research always leads to more questions than answers”.

SCIENCE IN PICTURE

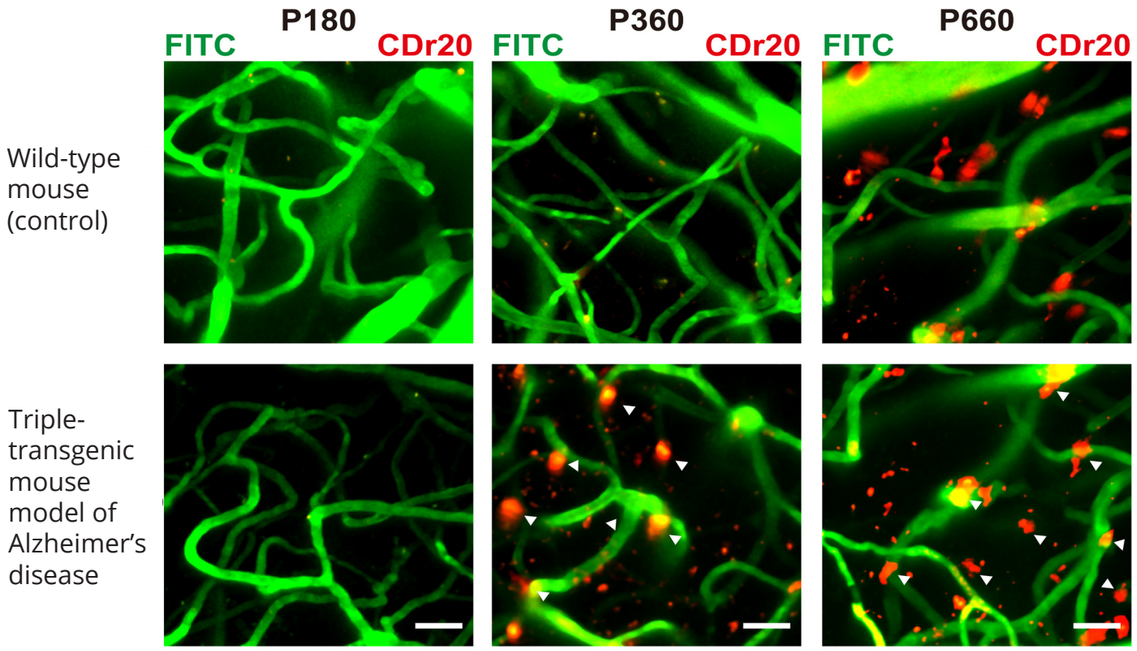

Photo: Duke-NUS Medical School

Researchers in South Korea and Singapore have, for the first time, developed a chemical probe that enables live-imaging of a type of immune cells, known as microglia, in a live animal brain. This discovery will enable critical imaging studies to help scientists understand the development of brain diseases, such as stroke, autism, Alzheimer’s and Parkinson’s disease.

This image shows microglia labelled by the chemical probe CDr20, imaged through a mouse brain. Three differently aged, wild-type or Alzheimer’s Disease model mice, were intravenously injected with CDr20. The red-labelled cells are the CDr20-labelled microglia, while the green areas are the blood vessels.

The researchers observed robust labelling of microglia via intravenously delivered CDr20 only in the cortex of Alzheimer’s Disease model mice from P360. They did not observe this labelling in the control mice of the same age. This indicates the early and selective detection of microglia in the Alzheimer’s Disease model mice with emerging cognitive deficits.

P660 mice are about 80-90 years-old in human age. P360 mice are about 40-50 years-old in human age.

Accordingly, the researchers think that CDr20 can label microglia at the pre-symptomatic stages of Alzheimer’s Disease.

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