A BETTER LIFE THROUGH RESEARCH AND DEVELOPMENT

Annual Report 2018/19
VISION
A Better Life through Research and Development

MISSION
We Catalyse Collaborative Research and Development of Innovative and Practical Solutions for a Better Life, and Nurture Research Talent
KEY HIGHLIGHTS OF THE YEAR

Programme Grants Committed in FY2018/19

$38 million*

Programme Grants Awarded in FY2018/19

$36 million

Total number of research talents groomed through the SMF Research Grant Programme since 2011

496

Total number of research talents groomed through the SMF Research Grant Programme in FY2018/19

111

Endowments

- **Singapore Millennium Foundation (SMF) Endowment**
- **STEM Endowment which supports the Temasek Life Sciences Laboratory**

Focus areas for SMF Research Grant Programme

**Learn Well**

Professor Liaw Sok Ying and her team from the National University of Singapore created a virtual platform known as “Create Real-Life Experience and Teamwork in Virtual Environment”, which aims to hone collaboration and communication skills among students across various healthcare disciplines.

Read more about how this virtual platform has helped students learn better on Page 20.

**Live Well**

National University of Singapore Emeritus Professor Lam Toong Jin believes Soon Hock fish can be grown in fish farms more sustainably. An aquaponics system has been developed, combining conventional aquaculture with hydroponics.

Read more about how the aquaponics system works on Page 22.

**Leave Well**

A team of Duke-NUS Medical School researchers surveyed the preferred treatment for end-stage renal failure among elderly patients and their caregivers. Led by Professor Eric Finkelstein, preliminary findings showed a lack of awareness about alternatives to dialysis, such as conservative management.

Read more about the team’s findings on Page 24.

Endowments

- **Singapore Millennium Foundation (SMF) Endowment**
- **STEM Endowment which supports the Temasek Life Sciences Laboratory**

Total of 58 programmes supported since 2011

14 programmes

29 programmes

15 programmes

Total of 10 programmes supported in Financial Year 2018/19

3 programmes

4 programmes

3 programmes

* This includes a $35 million grant under the STEM Endowment, which supports the Temasek Life Sciences Laboratory.
CHAIRMAN’S MESSAGE

Since the Temasek Foundation Innovates team was put in place in 2017, we have been meeting with researchers and experts in the field to gather feedback, enhance the current work that we do, and discover research needs that could potentially emerge in the next few years.

In March 2019, I had the opportunity to observe teachers and children at MINDS Fernvale Gardens School use the i-Tile to learn – a positive result of a research project the Singapore Millennium Foundation (SMF) Research Grant Programme has supported since 2015. Associate Professor Goh Wooi Boon of Nanyang Technological University, the Principal Investigator of the study, together with his team, have been working closely with the teachers at Fernvale Gardens School to pilot the i-Tile lesson designs. I was very pleased to see children having fun learning spelling, and in the process learning valuable life skills such as teamwork and communication. The teachers shared that their students have become more motivated to learn, since the i-Tile enables them to play, move around, and learn at the same time.

What is important about the research is not just the technology that was developed, but also how practical the solution is. The reconfigurable nature of the i-Tile allows teachers to adapt and design new activities to suit their students’ diverse learning needs, and at an affordable cost. This is very much what Temasek Foundation sets out to achieve – supporting research projects that are innovative and practical, and can be deployed to better the lives of people in Singapore.

I understand that Associate Professor Goh and his team are continuing to work with teachers to scale up the i-Tile lesson designs to other classes within Fernvale Gardens School. The i-Tile lesson designs can potentially be rolled out to other MINDS schools too.

Associate Professor Goh’s i-Tile is one of many projects Temasek Foundation has supported through the SMF Research Grant Programme. Since 2011, the Programme has funded 58 research projects and groomed over 450 research talents. Thirty-one of these research projects are still ongoing.

In FY2017/18, we made refinements to the SMF Research Grant Programme. We introduced joint and booster applications in our annual grant call, to encourage scientists to collaborate with partners from different research domains, and to facilitate their partnerships with practitioners who can translate their findings into deployable applications.

In FY2018/19, we broadened our work to focus on three key themes: Learn Well, Live Well and Leave Well. This gives us the flexibility to fund new studies that meet arising needs, while remaining committed to the existing areas we have been supporting. For the 9th Grant Call, which opened on 1 November 2018, we identified research topics within each theme that needed deeper exploration. We also introduced funding support for clinical trials for affordable and accessible healthcare solutions.
CHAIRMAN’S MESSAGE

Learn Well

Temasek Foundation’s interest in this area focused on learning which brings about lifelong skills, and learning in special situations where there may be some specific difficulties. As an example, we are supporting Institute of Mental Health’s Dr Ho New Fei to work with non-profit organisation EQUAL-ARK, to research into whether horse-assisted learning can help improve the resilience, socio-emotional development and academic performance of youths at risk.

Even as we invite proposals that study different ways to help different groups learn and grow better, we would like to give special attention to early childhood education. Our 9th grant call therefore specifically invited proposals on language acquisition in early childhood.

Live Well

Singapore relies largely on imported food products due to our limited land resources. The Foundation has been supporting various projects that aim to make local food production more sustainable and ensure that what we eat is safe. For instance, we are supporting a project by Temasek Polytechnic’s Dr Mandar Godge that aims to enhance the rejuvenation of soil and plant ecosystems in urban indoor integrated farming systems, to increase food production.

Living well is not just about what we eat, but also what we use. We therefore introduced a new area of interest for the 9th Grant Call, to encourage clinical trials for low cost solutions which may find less support in commercial settings, such as alternative wound care solutions.

Leave Well

As individuals, not only do we want to leave the world well, but we also want to leave behind a world fit for our future generations. At this point, our focus is on projects that look into how we can provide better palliative care for patients with terminal illnesses.

Dr Grace Yang’s study on the ENABLE (Educate, Nurture, Advise, Before Life Ends) programme is one such example. Through the ENABLE programme, nurses provide supportive care to patients with serious illnesses and their family caregivers. This programme has been successfully run in the United States, and Dr Yang aims to adapt and pilot test this nurse-led model in Singapore.

The 9th Grant Call is encouraging more studies on palliative care, especially for patients in the dementia continuum, as well as paediatric and young adult populations.

This journey of discovery and identifying new needs is an ongoing one for all of us at Temasek Foundation. I would like to thank members of the Temasek Foundation Innovates Board for their valuable insight and careful reviews of the research projects we support. I would also like to thank the many professionals in the field, who give their time generously to be part of our expert panels which conduct in-depth evaluations of the research proposals we receive. We will continue to reach out to scientists, institutions, hospitals and various organisations to ideate and test new models to address the needs and issues of people in Singapore.

Yours Sincerely

Professor Leo Tan
Chairman
BOARD OF DIRECTORS

1. **Professor Leo Tan** / Chairman
   Director of Special Projects, Faculty of Science,
   National University of Singapore

2. **Professor Cheah Horn Mun** / Director
   Assistant Provost, Singapore University of Social Sciences

3. **Associate Professor Cynthia Goh** / Director
   Senior Consultant, Division of Supportive
   and Palliative Care, National Cancer Centre Singapore

4. **Associate Professor Lim Tilt Meng** / Director
   Chief Executive, Science Centre Board

5. **Dr Ngiam Tong Tau** / Director
   Chairman, Sky Urban Solutions Holdings Pte Ltd

6. **Professor Quek Tong Boon** / Director
   Chief Scientific Advisor, Ministry of Trade and Industry

7. **Wong Heng Tew** / Director
   Advisory Director, Temasek International Advisors Pte Ltd
The Singapore Millennium Foundation (SMF) Research Grant Programme has been in place since 2011, when the Singapore Millennium Foundation started its programme of annual grant calls. Temasek Foundation Innovates took over the SMF Research Grant Programme in 2017.

FY2017/18 had seen the introduction of refinements to the grant programme, such as joint applications to encourage collaborations, and booster applications to encourage researchers to identify partners to bring their findings to the deployment stage.

FY2018/19 saw the opening up of the research areas we supported, to enable the exploration of more ideas. We complemented this with the introduction of “problem statements”, so that even as we broadened the areas we were open to support, we communicated clearly what we had identified as issues which needed most research attention. The 9th Grant Call which opened on 1 November 2018 hence invited applications focusing on three key areas: Learn Well, Live Well and Leave Well.

Apart from our annual grant calls, Temasek Foundation funded the Singapore Mental Health Study. Having supported the first Singapore Mental Health Study whose results were published in 2010, we continued to support the nationwide research led by the Institute of Mental Health, which culminated in the publishing of the findings in December 2018. The Foundation also continued to sponsor the Lee Kuan Yew Water Prize that recognises outstanding contributions by an individual or organisation towards solving the world’s water challenges. The Prize is a key highlight of the Singapore International Water Week.

**SMF RESEARCH GRANT PROGRAMME**

**FACTS AND FIGURES**

<table>
<thead>
<tr>
<th>Number of programmes supported</th>
<th>Total number of research talents groomed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Since 2011</td>
<td></td>
</tr>
<tr>
<td>LEARN WELL 29*  LIVE WELL 15</td>
<td>58</td>
</tr>
<tr>
<td>LEAVE WELL</td>
<td>496</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Financial Year 2018/19</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LEARN WELL 03  LIVE WELL 04*</td>
<td>10</td>
</tr>
<tr>
<td>LEAVE WELL</td>
<td>111</td>
</tr>
</tbody>
</table>

*Includes the Lee Kuan Yew Water Prize
SMF RESEARCH GRANT PROGRAMME

Learn Well

• Although funding for studies on learning and pedagogy already exists, we believe there continues to be niche areas which are under researched. This includes special needs education, early childhood education and education that is conducted outside of the formal school curriculum.

• For the 9th Grant Call, we highlighted our particular interest in research dealing with effective Language Acquisition in Early Childhood, specifically understanding language acquisition and development in a localised context, especially in children aged 0 to 3 years.

Live Well

• Catalysing innovative and practical solutions for a better life also means making a difference in what people need in their everyday living. We continue to be interested in projects which address challenges and issues in the areas of “Healthy Food, Healthy Earth”.

• In addition, the 9th Grant Call saw the introduction of a new area of interest, that of encouraging clinical trials for low cost solutions which may find less support, such as alternative wound care solutions.

Leave Well

• As we continue to grow as a society, we not only want to leave the world well, but also want to leave behind a world fit for our future generations.

• While we are open to ideas in this broad area, for the 9th Grant Call, we highlighted our keen interest in palliative care research - especially in patients in the Dementia Continuum, as well as Paediatric and Young Adult Populations of patients with life limiting or terminal illnesses.
LIST OF PROJECTS AWARDED FOR THE 8TH GRANT CALL

Learn Well

Mindset interventions to nurture strategic, self-regulated learners

DR PATRICIA CHEN
Faculty of Arts and Social Sciences, National University of Singapore

In today’s world where learning resources are more readily available, the onus is on the individual to be able to manage his or her own learning effectively. This research project aims to design interventions to help learners develop the mindset and capacity to practice self-regulated learning.

The project focuses on two key groups:

TERTIARY LEARNERS
Many of whom have to cope with less structure and more self-direction as they progress to post-secondary education and later into the workforce

PRE-SCHOOLERS
Who are starting to develop the cognitive capacity to think strategically for themselves

The effectiveness of these interventions will be tested using randomized, controlled experiments in the laboratory and in classrooms.

Equine-assisted learning on social cognition of at-risk youths

DR HO NEW FEI
Research Division, Institute of Mental Health

Community-based interventions are a sustainable way to boost skills required for at-risk youths to develop life-long competencies. Rigorous evidence on the benefits of horse-assisted learning interventions on at-risk youths is lacking. Hence, the research team will study the effects of a horse-assisted learning programme conducted by local non-profit organisation, EQUAL-ARK, which reaches out to 500 youth beneficiaries yearly.

The team will adopt a neuroscience approach to

a. Determine whether horse-assisted learning improves resilience, and socio-emotional functioning in at-risk youths, underpinned by alterations in interconnected brain circuitries; and

b. Determine whether improvements in horse-related learning leads to better academic performances and classroom behaviours.

Identifying determinants and making predictions of MENDAKI TUITION SCHEME (MTS) students’ academic performance – a sequential explanatory and data mining approach

ASSOCIATE PROFESSOR SYLVIA CHONG
Business Intelligence and Analytics, Singapore University for Social Sciences

This research project is conducted in partnership with Yayasan Mendaki. Mendaki was established in 1982, to empower the community through excellence in education. Today, Mendaki’s initiatives have expanded to cater to a sizeable percentage of Malay Muslim students at the lower and lowest socio-economic strata of the community. The programmes are meant to supplement or complement national education initiatives. Along with these expansions is a rapidly growing source of student information and data to be mined for insightful knowledge.

The project aims to describe, explain, predict and monitor Mendaki students’ performances. The aim of the project is to identify these determinants to improve teaching and learning, as well as to generate evidence-based insights to support and inform decision-making.
Live Well

Assessing the threat of a previously unknown foodborne pathogen (Group B Streptococcus) to the safety and resiliency of the food supply in Singapore

DR TIMOTHY BARKHAM
Department of Lab Medicine, Tan Tock Seng Hospital

DR SWAINE CHEN
Department of Medicine, National University of Singapore

DR MANDAR GODGE
School of Applied Science, Temasek Polytechnic

DR HUANG ZHI
School of Applied Science, Temasek Polytechnic

In 2015, a large human outbreak of Streptococcus agalactiae (GBS) occurred in Singapore, due to a single clone of GBS, sequence type ST283. Investigations into the outbreak led to new policies including banning the use of freshwater fish in ready-to-eat dishes, and requiring procurement of saltwater fish for raw consumption from AVA-approved suppliers. ST283 is now almost unseen in Singapore. However, other GBS strains (non-ST283) continue to cause human infections in Singapore (with about 230 invasive cases/year in adults), similar to other countries globally.

The research team hypothesizes that other GBS strains do cause foodborne disease in humans, and therefore GBS isolated from infected humans will be nearly identical to those found in food. The research team seeks to compare GBS isolated from humans with GBS isolated from food by whole genome sequencing, a strategy that successfully established the foodborne transmission of ST283. To do this, the team will sample food types commonly consumed by the public, and collect human GBS isolates from selected hospital laboratories across Singapore.

If other strains of GBS are found to be foodborne, this could provide further knowledge on GBS in turn enhancing regulatory policies and surveillance tools to ensure the resiliency of Singapore’s food supply.

Innovative system for rejuvenation of soil and plant ecosystem in urban indoor farming systems

DR MANDAR GODGE
School of Applied Science, Temasek Polytechnic

The introduction of innovative agricultural methods to increase food production will eventually lead to greater stability in the food ecosystem and promote a more sustainable environment. This research project aims to enhance the rejuvenation of soil using specific fungal species, thereby rendering them usable for multiple planting seasons. If successful, this will alleviate a major limiting step for the urban farmers.

Light has visible effects on the metabolic activity of fungi, bacteria and plants. This research adopts a combination of light-emitting diode (LED) lights, mycorrhizal fungi (AMFs), plant hormones and accumulation of flavonols. This combination enhances the yield and nutrition in fruits and vegetables, as well as rejuvenates the soil ecosystem.

The novel area the project explores is the use of LED lights with specific wavelengths for combinatorial photo-activation of AMFs, fruits, vegetables and soil. This robust system would promote cultivation of fruits and vegetables of economic importance for urban farming. The system developed by Dr Mandar Godge will be test bedded by Agri-Food and Veterinary Authority of Singapore and commercial partners.

A novel recycle aquaculture system for high efficiency nitrogenous waste elimination

DR HUANG ZHI
School of Applied Science, Temasek Polytechnic

Over the decades, aquaculture is maturing more rapidly than any other animal food-producing sectors. The use of recirculating aquaculture system (RAS) technology is promising and can lead to more sustainable farming. Currently, the removal of ammonia waste in RAS is done by biofiltration i.e. converting ammonia to nitrate by nitrification. Moving Bed Bioreactor (MBBR) is the most popular commercial biofiltration process.

Dr Huang Zhi aims to create an integrated solution for ammonia waste elimination in both freshwater and saltwater RAS. First, to overcome the shortage of MBBR, a novel Spinning Bed Bioreactor will be developed to achieve high-efficiency nitrification. Second, an Anaerobic Ammonium Oxidation Chamber will also be devised to minimize the accumulation of nitrate in RAS.

The research team will be collaborating with Blue Aqua International Pte Ltd, which will provide technical input, as well as assess its suitability for commercialization.
Leave Well

Survival expectations and hope among cancer patients at end-of-life

PROFESSOR ERIC ANDREW FINKELSTEIN
Lien Centre for Palliative Care, Duke-NUS Medical School

Many international studies and locally collected data from the COMPASS study of advanced cancer patients report that patients are overly optimistic about their prognosis.

Professor Eric Finkelstein and his team hypothesize that the disconnect between patient-reported prognosis and actual survival data arises because many patients are reporting not what they believe, but what they would like to believe. This study aims to test this hypothesis (i.e. to discern patient’s beliefs about prognosis independent of hope) via a specially designed incentive-compatible survey. The team also aims to identify factors that influence patient’s beliefs and how doctor-patient communication can be tailored based on patients’ preferences for prognostic information.

The team will be surveying cancer patients with a prognosis of less than one year, nested within a randomized controlled trial. Overall, this study aims to address and improve decision making at end of life – an important component of quality palliative care.

ENABLE is a nurse-led programme that provides supportive care to patients with serious illnesses and their family caregivers. For instance, a nurse would meet with patients to help them match resources to their needs, as well as conduct training in problem-solving skills to reduce distress and help them make decisions on issues such as symptom management. ENABLE has shown to improve patient outcomes in the American context e.g. better quality of life, less depressed mood and longer survival. The ENABLE sessions, originally conducted by advanced practice nurses, now have the potential for delivery by registered nurses. It is therefore scalable and feasible for widespread implementation.

This study aims to adapt and pilot test the ENABLE programme in Singapore. The research team will interview healthcare professionals, advanced cancer patients and caregivers, to get their views on the relevance of topics covered in the ENABLE programme and other topics that may be useful to include. The team will consult a multi-disciplinary advisory group on the interview results, as well as ways the ENABLE content can be adapted for cancer patients in Singapore.

The adapted ENABLE-SG programme will be piloted among advanced cancer patients and their caregivers across Khoo Teck Puat Hospital, National Cancer Centre and Tan Tock Seng Hospital. The ENABLE-SG programme may be also adapted for other serious illnesses such as heart failure.

@Enable is a nurse-led programme that provides supportive care to patients with serious illnesses and their family caregivers. For instance, a nurse would meet with patients to help them match resources to their needs, as well as conduct training in problem-solving skills to reduce distress and help them make decisions on issues such as symptom management. ENABLE has shown to improve patient outcomes in the American context e.g. better quality of life, less depressed mood and longer survival. The ENABLE sessions, originally conducted by advanced practice nurses, now have the potential for delivery by registered nurses. It is therefore scalable and feasible for widespread implementation.

This study aims to adapt and pilot test the ENABLE programme in Singapore. The research team will interview healthcare professionals, advanced cancer patients and caregivers, to get their views on the relevance of topics covered in the ENABLE programme and other topics that may be useful to include. The team will consult a multi-disciplinary advisory group on the interview results, as well as ways the ENABLE content can be adapted for cancer patients in Singapore.

The adapted ENABLE-SG programme will be piloted among advanced cancer patients and their caregivers across Khoo Teck Puat Hospital, National Cancer Centre and Tan Tock Seng Hospital. The ENABLE-SG programme may be also adapted for other serious illnesses such as heart failure.

Development and evaluation of a Narrative E-Writing Intervention (NeW-I) for parents of children with life-limiting illness

DR ANDY HO
School of Social Sciences, Nanyang Technological University

Conventional grief support interventions for parents whose children are terminally ill often begin only after the child’s death. There are evidences that prove pre-loss interventions can help parents better cope with grief.

Research has found that the narrative approach helps individuals get in touch with emotions that are challenging to accept and generate new meaningful stories about life. The research team has thus developed the Narrative e-Writing Intervention (NeW-I) for parents anticipating the death of their child. As most parents may not have the time to engage in sit-and-talk therapy, the NeW-I is a therapist-facilitated online platform that allows greater reflection of experiences and emotions.

A randomized control trial with a built-in qualitative evaluation and feasibility study will assess the effectiveness of the NeW-I. The NeW-I will be piloted across Singapore, in collaboration with KK Women’s and Children’s Hospital and Club Rainbow Singapore. The NeW-I aspires to improve quality of life and emotional well-being of parents facing the terminal illness and eventual death of their sick child. The research findings will serve to inform and enhance holistic paediatric palliative care locally and internationally.
HIGHLIGHTS OF PAST GRANT CALLS

Learn Well

Healthcare students learn to work in teams through virtual reality

In today’s healthcare setting, it has become more common for healthcare professionals of various expertise to collaborate as a team, so as to achieve the best outcome for their patients. The lack of effective communication among inter-professional healthcare teams, however, has been identified as one of the causes of medical errors and negative health outcomes.

In response to this, Professor Liaw Sok Ying and her team from the National University of Singapore (NUS) created a virtual platform known as “Create Real-Life Experience and Teamwork in Virtual Environment (CREATIVE)”, which aims to hone collaboration and communication skills among students across various healthcare disciplines. The team’s research and development of CREATIVE started since 2016.

CREATIVE allows students to practice working as part of an inter-professional team to treat a patient in a simulated environment, without having to deal with issues such as scheduling and geographical locations. Students get to work with more medical professionals, and in the process be exposed to more opportunities to learn how to communicate better within a team of professionals. The importance of face-to-face interactions is not forgotten, as the CREATIVE virtual reality environment seeks to complement the students’ training. As part of the students’ existing curriculum, they would still be required to undergo physical ward simulations, and be attached to various hospitals to work with patients under supervision.

An initial pilot test was conducted in 2017, with 29 students from Nanyang Polytechnic, Singapore Institute of Technology and NUS. These students majored in six different healthcare disciplines, namely, medicine, nursing, pharmacy, social work, physiotherapy and occupational therapy. Students using the system during the pilot felt that learning in a virtual environment was perceived as less “threatening” in the first instance, compared with face-to-face interactions.

Professor Liaw’s team hopes to further refine the platform, with an eventual goal of incorporating the finished product into students’ course curriculum.
Recirculating systems for sustainable farming

With little farming land and limited fishing grounds, Singapore is turning to sustainable aquaculture to help stabilise the country’s seafood supply by reducing its dependence on seafood caught from seas and rivers.

Emeritus Professor Lam Toong Jin of National University of Singapore believes that fish can be grown in fish farms more sustainably. Professor Lam and his team were awarded grants from Temasek Foundation Innovates to develop two key projects. The first project, which began in 2012, led to the development of a vertical recirculating aquaculture system for the production of Soon Hock fish (Marbled Goby), while the second project in 2013, looked into co-culturing the Soon Hock fish with other seafood (e.g. pacific white shrimp and tilapia) and plants.

The aquaponics system created by Professor Lam and his team combined conventional aquaculture with hydroponics. Water is fed into a hydroponic system where the waste by-products of the Soon Hock fish are broken into nitrates, which are then utilised by plants as nutrients, while the water is recirculated back through the system. Additionally, the waste by-products may also be fed to aquatic animals such as tilapia, shrimps and bivalves.

With this aquaponics system, fish farmers are able to channel the wastes from the Soon Hock fish as food for plants and other types of fishes for growth, while managing the water quality successfully. Professor Lam has also proven that this system is scalable not simply for small home systems, but for large farm systems as well.

Professor Lam and his team have been able to spawn the fish and raise the larvae through metamorphosis to the fry stage (the point where they can be cultured in farms to marketable size). The hatchery and nursery protocols have been worked out, and they have been able to produce thousands of fry. They have also been able to wean the fry to feed on artificial pelleted feed. Subsequently the fry can be grown to marketable size easily through the feeding of feed pellets.

With the conclusion of the research in 2016, Professor Lam is currently exploring collaborations with commercial entities on further developing this system for the culture of Soon Hock, cockles, shrimps and other seafood.
Leave Well

Creating more awareness of alternative treatments for end stage renal disease

Professor Eric Finkelstein and his team from Duke-NUS Medical School conducted a study to better understand the primary factors behind the high rate of dialysis, in particular haemodialysis (HD), among elderly end-stage renal disease (ESRD) patients in Singapore.

The team administered a survey with 161 elderly patients with chronic kidney disease, and their family caregivers, at renal clinics in Singapore General Hospital. Their research, concluded in 2017, showed that more than half of the respondents were not aware of alternative treatments such as conservative management (CM), and had little idea of the differences between treatment options.

For elderly ESRD patients who are unlikely to receive a transplant, dialysis is typically the first line treatment. Patients can choose between HD, which takes place in a dialysis centre, or peritoneal dialysis (PD), which can be performed at home but on a more frequent basis.

The goal of CM is to optimize quality of life by using medication to maintain current kidney function, and to treat the symptoms of kidney failure, such as shortness of breath and poor appetite.

For patients aged 75 years and older with multiple comorbidities (additional diseases or disorders), the U.S. Renal Association and other international bodies consider CM to be a viable alternative to dialysis. This is mainly due to the lack of clear evidence showing a superior survival advantage of dialysis for this population subset. Compared to dialysis, CM patients also experience lower rates of hospitalisation, lower costs and a lower burden of disease.

One might therefore expect CM to be a common treatment choice for elderly ESRD patients with multiple comorbidities. Yet, in Singapore, as with many other developed countries, the vast majority receive dialysis due to various reasons such as the lack of knowledge about CM as a viable treatment option, affordability of dialysis due to subsidies, and caregivers overestimating the survival benefits of dialysis.

The team’s research revealed the importance of providing high-quality information tailored for elderly patients in an unbiased and objective manner. As a follow-up, the team is developing educational materials, such as a video and brochures, to aid elderly ESRD patients and their caregivers in making the right decision for treatment. The materials will convey the pros and cons of the different treatment options including CM.
TEMASEK LIFE SCIENCES LABORATORY

Temasek Life Sciences Laboratory (TLL) is a key beneficiary of the STEM Endowment. The funding supports TLL’s vision to build an organisation of global talents to undertake research and develop applications to benefit people in Asia and beyond. TLL has over 200 scientific and support staff who work on both basic and strategic research programs, centred around five core research areas namely:

1. Food Agri-Biotechnology
2. Industrial and Synthetic Biotechnology
3. Human and Veterinary Science
4. Cellular Biosciences
5. Science and Education

Pathogen-resistant mosquitoes using CRISPR/Cas9 technology

Mosquito-borne diseases impose an enormous burden on our society locally and globally. Current control methods rely heavily on chemical insecticides, which leads to negative impacts on the environment, as well as the development of insecticide-resistant mosquitoes. Alternative novel control strategies that are specific and maintain biodiversity are required.

Since January 2017, Dr Cai Yu, a Principal Investigator at TLL, has been working on a research project that leverages on the cutting edge CRISPR/Cas9 technology to generate genetically-engineered mosquitoes that carry anti-pathogen effector genes.

This method recognizes that every single living organism exists and occupies a special niche in the current ecosystem. The extinction of any organism will have some yet-to-be-known consequence in this delicate ecosystem. Mosquitoes also play an ecological role. Hence, instead of eradicating them from the ecosystem, scientists have long attempted to fight mosquito-borne diseases by replacing pathogen-sensitive mosquitoes with pathogen-resistant counterparts, so as to preserve the mosquito species in the current ecosystem.

Dr Cai Yu is attempting to generate anti-pathogen effector genes which have the ability to spread rapidly into the wild mosquito population within few generations upon its release (the “gene drive” technology). By carrying the anti-pathogen effector genes, the wild mosquito population cannot carry and transmit the virus. This technology can also work synergistically with other available control methods to effectively reduce the burden of mosquito-borne diseases.
In FY2018/19, Temasek Foundation Innovates committed funds amounting to $38 million. The funds were committed to 10 programmes supported under the SMF Endowment, and grants extended to the Temasek Life Sciences Laboratory supported under the STEM Endowment. Through the SMF Endowment, we groomed over 100 research talents in FY2018/19.

We have broadened the research areas we supported to enable the exploration of more ideas, complemented with the introduction of “problem statements” to specify issues that needed most research attention. The 9th Grant Call, which opened on 1 November 2018, hence invited applications focusing on three key areas: Learn Well, Live Well and Leave Well.

Our expense ratio for FY2018/19 was 1.78%. This figure includes expenses incurred in engaging staff services to manage the different programmes and endowments.

As part of the best practices encouraged under the Code of Governance governing charities and Institutions of Public Character, the declaration pertaining to our Board of Directors, as well as our Reserves, Conflict of Interest and Whistle Blowing policies are set out below.

**Board of Directors**
The Board of Directors of Temasek Foundation Innovates do not receive any form of remuneration. The number of meetings of the Board held in FY2018/19 and the attendance of the Directors at those meetings are tabulated below.

<table>
<thead>
<tr>
<th>Board of Directors</th>
<th>Attendance</th>
<th>Date of Appointment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tan Wee Hin Leo</td>
<td>3 out of 3</td>
<td>23 May 2016</td>
</tr>
<tr>
<td>Cheah Horn Mun</td>
<td>2 out of 3</td>
<td>17 October 2017</td>
</tr>
<tr>
<td>Goh-Fung Cynthia Ruth</td>
<td>3 out of 3</td>
<td>1 September 2016</td>
</tr>
<tr>
<td>Lim Tit Meng</td>
<td>2 out of 3</td>
<td>1 September 2016</td>
</tr>
<tr>
<td>Ngiam Tong Tau</td>
<td>3 out of 3</td>
<td>1 September 2016</td>
</tr>
<tr>
<td>Quek Tong Boon</td>
<td>2 out of 3</td>
<td>1 September 2016</td>
</tr>
<tr>
<td>Wong Heng Tew</td>
<td>3 out of 3</td>
<td>1 April 2016</td>
</tr>
</tbody>
</table>

"Expense Ratio" is defined as the ratio of Operating and Capital Expenditure to the Programme Grants Committed Budget for the financial year.

**Reserve Policy**
The Foundation’s activities are adequately funded by Temasek Trust to meet all its cash requirements.

**Conflict of Interest Policy**
Temasek Foundation Innovates has a Conflict of Interest Policy wherein all Directors are made aware of, and declare, any conflict of duality of interest in a given situation, and abstain from decision-making at any meeting in which the subject of the conflict is discussed. Temasek Foundation Innovates engages staff services from Temasek Foundation International, and these staff are similarly required to adhere to a documented conflict of interest policy.

**Whistle-Blowing Policy**
Temasek Foundation Innovates has in place a Whistleblowing Policy for all Directors, to enable them to raise concerns regarding malpractice, impropriety, statutory non-compliance or wrongdoing, with assurance of confidentiality and without fear of reprisal, discrimination or adverse consequences. Similarly, a Whistleblowing Policy is in place for all Temasek Foundation International staff, which provides staff services to Temasek Foundation Innovates.

**Financial Statements**

**Management Team**

**Koh Lin-Net**
Chief Executive
Date of Appointment: 14 November 2016

**Khoo Yik Lin**
Senior Director
Temasek Foundation supports a diverse range of programmes that uplift lives and communities in Singapore and beyond. Temasek Foundation’s programmes, made possible through philanthropic endowments gifted by Temasek, strive towards achieving positive outcomes for individuals and communities now, and for generations to come. Collectively, our programmes strengthen social resilience, foster international exchange and regional capabilities, and advance science and nature.

**Strengthening Social Resilience and Uplifting Lives**
We endeavour to build a more resilient, harmonious and inclusive society in Singapore. Our outcome-focused programmes help to enhance our social fabric by supporting individuals, strengthening families and uplifting communities. We pilot programmes and research as well as support programmes that promote culture, heritage and values to benefit current and future generations.

**Fostering International Exchange and Enhancing Regional Capabilities**
We connect people through programmes that promote dialogues, mutual understanding and a more inclusive worldview. Our programmes also advance capability and capacity in areas such as healthcare, education, public administration, urban management, and disaster response.

**Advancing Science and Nature for a Sustainable World**
We champion sustainability and support research and education in science, technology, engineering and mathematics, and solution-oriented development projects that contribute to improving liveability. These programmes strengthen research capabilities and promote cross-functional collaboration in areas such as healthcare, education, climate change, wildlife conservation and the circular economy.