2015 PSTA WINNER CITATIONS

PRESIDENT'S SCIENCE AND TECHNOLOGY MEDAL 2015

Tan Gee Paw
Chairman,
PUB Singapore

"For his pivotal role in harnessing science and technology to enable Singapore to achieve sustainable water supply, and to become a global water hub. He formulated Singapore's first water master plan in 1972 and played a central role in the development of Singapore's NEWater and desalination capabilities. His outstanding leadership in Singapore's water R&D effort has made a profound impact on water sustainability, and spawned a thriving water and environment research, development and industry ecosystem in Singapore."

Mr Tan Gee Paw has made exceptional contributions through his leadership in the exploitation of science and technology to help Singapore achieve sustainable water supply and to become a global water hub. Most of his distinguished career has centred on advancing Singapore's water management system. In 1972, Mr Tan formulated a plan of action to create estuarine reservoirs and urbanised catchments, which also envisioned closing the water loop by capturing and reusing every drop of water. The underlying aim of this plan was to bring about Singapore's sustainability in water supply.

To bring this plan into fruition, Mr Tan systematically exploited R&D leading to his critical strategic contribution in the form of the development of 2 unconventional sources of water for Singapore – NEWater in 2002, and desalinated water in 2005 which used membrane technology for the first time. This technology was combined with the development of new catchments outside traditional water supply schemes. In particular, Mr Tan played a key leadership role in the inter-agency committee responsible for the clean-up of the Singapore River and the Kallang Basin. The clean-up was completed ten years later, and among other socio-economic benefits, had paved the way for the development of the Marina Barrage. The R&D effort in PUB has its roots in Mr Tan's pioneering experience with NEWater. He developed deep engineering R&D capabilities in PUB and forged an organisational culture that embraces experimentation with emerging technology as a means to provide new and more effective water solutions.

By leveraging technological innovations, Singapore has been able to overcome the water challenge. These successes have given PUB the confidence to pursue R&D with even greater vigour. Since 2003, PUB has supported more than 400 projects and continues to undertake major engineering and technologically challenging projects such as the Deep Tunnel Sewerage System, a superhighway for used water management. Mr Tan's leadership at the helm of the R&D Committee in PUB has

expanded the traditional boundaries of water management into the development of sustainable technologies to comprehensively manage water collection, reclamation and disposal. Under his stewardship, PUB was awarded the prestigious Stockholm Industry Water Prize, one of the highest accolades for outstanding achievements in the global water arena. Mr Tan's experiences in NEWater, commitment to R&D, and leadership have also had a subtle but pivotal impact on the water and environmental research ecosystem in Singapore that had evolved since NEWater. He is the key driver of the Water Technology and Environment R&D landscape in Singapore since leading PUB in its initial efforts in water research and the establishment of the Environment and Water Industry Programme Office (EWI) in May 2006. His vision is to create a long term plan to build up the ecosystem with space for both the public and private sectors.

Mr Tan has played a role both downstream, by supporting research and stimulating companies to adopt technology, and upstream by building the water research ecosystem. The water R&D initiatives driven by Mr Tan have created enormous value for Singapore, in job creation, in attracting international water companies to locate their operations in Singapore, as well as in strengthening Singapore's water R&D capabilities and competitiveness. The high level of water, environmental and membrane research in the public and private sector would not have been possible without PUB's pioneering effort, under his leadership. Always humble and nurturing towards young scientists and engineers, Mr Tan generously shares his expertise and experience in environmental and water management by serving on several advisory panels, including the Environment and Water Technologies International Advisory Panel (EWT-IAP) and the Institute of Water Policy at the National University of Singapore. Water, once a strategic weakness of Singapore, through Mr Tan's 40 years of perseverance and single-minded focus, has now become a competitive advantage for Singapore.

A thriving global water industry and the setting up of numerous water research institutions including those established by foreign companies owe much to Mr Tan's dedication to advancing the nation's water management system and realising water sustainability through science and technology. Through his efforts, Singapore has emerged as a model for sustainable urban water management to cities around the world. For his leadership, and impact on water sustainability, which has spawned a thriving water and environment research, development and industry ecosystem in Singapore, Mr Tan Gee Paw is awarded the 2015 President's Science and Technology Medal.

PRESIDENT'S SCIENCE AWARD 2015

Professor Patrick Tan
Cancer and Stem Cell Biology
Duke-NUS Graduate Medical School Singapore/Genome Institute of Singapore

Professor Teh Bin Tean
Division of Medical Sciences
National Cancer Centre Singapore

Professor Steven Rozen
Cancer and Stem Cell Biology and Centre for Computational Biology
Duke-NUS Graduate Medical School Singapore

"For outstanding integrative and translational research in Asian cancer genomics"

Professors Patrick Tan, Teh Bin Tean, and Steven Rozen are recognized for their discoveries of new genes and molecular pathways in various types of Asian cancers. Over the past eight years, these scientists have pursued multi-disciplinary and collaborative "team-science". Using innovative genomic platforms and biological approaches including next-generation sequencing, they have interrogated the genomes of Asian cancers, identifying novel targets for improved therapeutics and diagnostics.

Asian cancers represent a vast unmet clinical need. The World Health Organization estimates that in 2012, there were 14 million new cancer cases worldwide and 8.2 million cancer-related deaths. These numbers will rise dramatically over the next two decades and will particularly impact Asia. By 2030, 70% of the world's cancer deaths will occur in Asia and developing countries. Importantly, because different cancers can display tremendous geographic variation, many cancers endemic to Asia are different from those in Western countries, and comparatively little is known about their underlying molecular genetics. Thus, Asian cancers are an urgent area to which scientific and medical attention should be focused to develop novel therapeutic, diagnostic, and preventive strategies.

The Tan/Teh/Rozen team has addressed this problem through an integrated biological research program spanning basic science, translational research, and clinical studies. Focusing on four Asian malignancies (stomach, biliary tract, urinary tract, and breast fibroepithelial tumors), the team identified novel genetic alterations, investigated relationships between these alterations and environmental factors, and mapped how these contribute to disease. Their results have led to strategies for the improved diagnosis, treatment, and prevention of such cancers. The Tan/Teh/Rozen "team-science" approach, reflected in their outstanding record of joint publications and trainee co-supervision, has resulted in a steady stream of notable scientific breakthroughs documented by multiple publications in high-impact journals including Nature Genetics, Cancer Discovery, and Science Translational Medicine. Some of the team's key discoveries include:

a) Discovery of specific molecular signatures associated with exposure to aristolochic acid (AA), a carcinogen found in certain herbal remedies, and its role in liver and bladder cancer.

b) Identification of genes mutated in breast fibroepithelial tumors, including the MED12 gene that is mutated in 60% of breast fibroadenomas, a condition found in 10% of women worldwide

c) Demonstration of the role of chromatin modifier genes such as ARID1A and BAP1 in stomach and biliary tract cancers.

The team's work has also garnered substantial translational impact and attracted significant industry funding of close to S$4 million for collaborative research projects with multiple pharmaceutical companies such as Roche, GSK, Bayer, Novartis, and Principia Biopharma.

The team is also internationally recognized as a leader in the field of Asian cancer genomics, by being invited to participate in the International Cancer Genome Consortium to lead programs in biliary

tract cancers and T-cell lymphomas. Team members Tan and Teh have also been elected to the American Society of Clinical Investigation, a prestigious honor society of physician-scientists.

The team's research has been performed in their capacity as faculty members of Duke-NUS Graduate Medical School Singapore, in collaboration with other national institutes. Professors Tan and Teh carry joint appointments with the Genome Institute of Singapore and National Cancer Centre Singapore respectively, and the team is also affiliated with the Cancer Science Institute of Singapore and the Institute of Molecular and Cell Biology. For their outstanding research on Asian cancer genomics, Professors Patrick Tan, Teh Bin Tean, and Steven Rozen are awarded the 2015 President's Science Award.

PRESIDENT'S TECHNOLOGY AWARDS 2015

Professor Neal Tai-Shung Chung
Department of Chemical & Biomolecular Engineering,
National University of Singapore

"For his outstanding research work on various novel membrane technologies, especially for water treatment, that have shown significant potential to make desalination more energy efficient and environmentally friendly, and that have helped to establish Singapore as a leading research centre for water research"

Professor Neal Chung has made major contributions to the field of membrane science. Not only has he furthered the fundamental understanding of membranes, but he has also been responsible for the development of numerous novel membrane designs that have been recognised by academics for their innovativeness, and adopted by industry for clean water and clean energy applications.

As a consultant to Hyflux, Prof Chung built and led its membrane R&D team from 2004-2008. There, he co-invented the Kristaltm 600 hollow fiber ultrafiltration membrane with Hyflux researchers, which has since been commercialised worldwide. This product was developed with Singapore's specific water treatment needs in mind by protecting public health through the use of stringent filtration methods to remove viruses and other contaminants. Today, the technology is so successful that it is not only used in Singapore's water recycling plants, but also globally as a pre-treatment in large seawater reverse osmosis (SWRO) plants.

Prof Chung and his team at NUS developed numerous novel membrane materials with various clean water and energy applications. One of these inventions is a double-repulsion nanofiltration (NF) membrane that effectively removes both positive and negative charged multivalent ions from industrial effluents. This technology allows for improved filtration of toxic heavy metal ions, such as arsenic, from industrial wastewaters. Two companies have already licensed this technology for commercialisation.

Prof Chung and his team successfully developed a novel process for advanced high flux forward osmosis (FO) membranes which surpasses the performance of most conventional NF processes, achieving a 99.5 per cent rejection rate for heavy metal ions. FO membranes with high oil rejections have also been developed to treat oil or water mixtures. Whilst these FO membranes primarily address the recycling of industrial wastewater, they have the potential to address wider problems such as water shortages in water scarce regions or groundwater contamination from pollutants.

Prof Chung also pioneered the design of biomimetic membranes by utilising aquaporin, a type of protein that allows fast transmission of water molecules, but blocks the passage of larger molecules and salts. These technological advancements increase the feasibility of fast desalination for fresh water reclamation.

Prof Chung and his team have also created innovative pressure retarded osmosis (PRO) membranes which have been noted for displaying the highest power density and mechanical strength ever recorded in scientific literature. These membranes could significantly lower energy consumption and production costs for seawater desalination if integrated with osmotic power generators and RO plants. Such an approach would also reduce or eliminate the need for complicated methods of RO brine disposal, creating a more streamlined and environmentally-friendly desalination process. Prof Chung was awarded grants in three rounds of the Competitive Research Program funded by the National Research Foundation. He and the team he built at NUS have published extensively and hold numerous patents. As an acknowledgement of his contributions to the field of water research, Lux Research USA, a consulting firm providing strategic data on emerging technologies, ranked NUS in 2013 as the global leader in water research, specifically citing Prof Chung's work on membranes for clean water.

As a faculty member of the National University of Singapore, Prof Chung is also passionate about nurturing students so that they may one day contribute to global efforts undertaken for cleaner water at lower cost. Prof Chung has trained 55 doctoral students, 18 Masters students and more than 70 post-doctorate fellows, who have gone on to become professors as well as entrepreneurs. Some of his students have also been recruited by major transnational corporations.

For his outstanding research and innovative work on membranes, particularly in the field of water, Professor Neal Chung is accorded the 2015 President's Technology Award.