SMART

Singapore-MIT Alliance for Research and Technology

SMART introduces three research initiatives to revolutionise diagnostic capabilities for health applications

Supported by grants disbursed by the National Research Foundation (NRF), these studies will aid the further development of nanosensor technology for the detection of foodborne bacteria and gut health, and microfiltration technology for infectious disease diagnosis

- The Intra-CREATE grants by NRF facilitate increased interdisciplinary collaboration among researchers from SMART and other CREATE research institutions
- These novel projects build on existing technologies developed at SMART

Singapore, 18 April 2023 – Three research teams from the Singapore-MIT Alliance for Research and Technology (SMART) – MIT's research enterprise in Singapore – alongside their partner institutions, have been awarded Intra-CREATE grants by the National Research Foundation (NRF) Singapore. The grants are part of the NRF's initiative to bring together researchers from institutions under the Campus for Research Excellence and Technological Enterprise (CREATE) in order to achieve greater impact from collaborative research efforts.

The first two grants have been awarded to researchers from SMART's Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP) interdisciplinary research group (IRG) to develop food packaging capable of detecting foodborne bacteria, and a rapid test kit to rapidly assess gut health from blood serum and stool samples. The third grant is jointly awarded to a joint research team from SMART's Antimicrobial Resistance (AMR) and Critical Analytics for Manufacturing Personalized-Medicine (CAMP) IRGs, for the development of a novel diagnostic technique capable of rapidly detecting low-abundance pathogens in biological samples.

Combining nanosensor technology and food packaging for foodborne bacteria detection

Hosted by SMART DiSTAP in collaboration with the National University of Singapore (NUS), the research project *"Biodegradable silk-nanocomposite multifunctional films for sustainable, smart and active food packaging"* aims to develop a protein-based, biodegradable and multifunctional food packaging solution capable of detecting and combating foodborne pathogens in real time.

Foodborne illnesses are often caused by bacteria, fungi, parasites and viruses, and food packaging plays an important role in maintaining food safety and freshness. However, conventional food packaging materials are passive barriers that can only delay the adverse effects of contamination, and many are made of synthetic plastics and petroleum-derived polymers which contribute to environmental waste and pollution.

Co-led by Dr Yangyang Han, Postdoctoral Associate at SMART DiSTAP, and Dr Tedrick Thomas Salim Lew, Assistant Professor at NUS' Department of Chemical and Biomolecular Engineering, this novel and sustainable approach aims to enable early and real-time detection of specific foodborne bacteria. This will be achieved by replacing plastic-based packaging with nature-derived protein-based films with added stimuli-responsive nanosensors and antimicrobial hydrogels.

"Food safety and waste represent a major societal challenge with significant health, economic, and sustainability implications, and our goal is to provide a sustainable alternative to protect food safety while reducing spoilage and environmental waste," said **Dr Han**. "The interdisciplinary nature of this project – which combines the fields of biomaterials, nanotechnology, food safety, toxicology, sustainability and microbiology – will result in a novel solution to better understand pathogen sources and spread mechanisms in the food supply chain."

Point of care sensing kit to rapidly determine gut health from blood serum and stool samples

SMART DiSTAP's "*Rapid detection of Indole-3-propionic acid and development of Raman spectral library for gut health monitoring using a portable spectrometer (RIDRaGS)*" project, which combines the expertise of researchers from SMART, MIT, National University Hospital (NUH), NUS Yong Loo Lin School of Medicine (NUS Medicine) and Duke-NUS Medical School, seeks to develop the first sensor capable of instantly detecting the presence of Indole-3-propionic acid (IPA) in blood serum and stool samples.

Digestive diseases constitute one of the highest disease burdens in our community, and persistent gut inflammation and microbial imbalance have been identified as key contributors to obesity, cardiovascular-metabolic diseases, accelerated ageing and cancer. IPA, a small-molecule metabolite produced by the human gut microbiota, is an emerging indicator of gut health as it regulates the gut immune response and inhibits excessive inflammation. Patients with active gut inflammation have depleted IPA levels, while recovery from the inflammation restores IPA concentration.

Co-led by Dr Mervin Chun-Yi Ang, SMART DiSTAP Associate Scientific Director, and Dr Lee Wei Jie Jonathan, Consultant at NUH's Division of Gastroenterology & Hepatology and Assistant Professor at NUS Medicine, this project focuses on utilising portable spectrometers – which have been developed by DiSTAP for other biological applications such as non-invasive plant health monitoring – to rapidly detect IPA levels in blood or stool samples. This will help to enhance the efficiency of the testing process, as IPA is traditionally analysed through conventional mass spectrometry-based techniques and the use of specialised lab equipment.

"Nutrition, microbiome and anti-inflammatory approaches have received great attention in recent years and are hailed as some of the most promising research areas that will address the country's healthcare challenges," said **Dr Ang**. "Building on SMART DiSTAP's success in customising portable spectrometers for different agricultural applications, we are excited to further develop these tools and see how they can be also applied to healthcare and medicine."

Rapid diagnosis of infections and monitoring of cell therapy product contamination using electrostatic microfiltration

Hosted by SMART IRGs AMR and CAMP in collaboration with the Singapore Centre for Environmental Life Sciences Engineering (SCELSE), "*Electrostatic microfiltration-based enrichment of low-abundance pathogens and improves downstream detection performance*" seeks to produce a novel diagnostic technique capable of rapidly detecting low-abundance pathogens in biological samples.

When a patient is sick from an infection, particularly in their blood, it takes up to seven days to detect pathogens using conventional methods. This hinders timely and appropriate diagnosis and treatment, and worsens the prognosis. A similarly delayed process occurs in cell therapy product manufacturing, where it takes between seven to 14 days to evaluate the presence of contaminants such as bacteria, virus and fungi. Because cell therapy products cannot be sterilised, detecting contaminants early on to restart the production cycle is urgently needed so that the products can be delivered to patients quickly and safely.

The research team, led by Dr Yaoping Liu, Senior Postdoctoral Associate at SMART CAMP, and Dr Irvan Luhung, Senior Research Fellow at SCELSE, in their previous research, have developed electrostatic microfiltration as an effective sample preparation device for bacteria enrichment, and aim to integrate the microfilter with mainstream detection methods. This enables the bacteria to be detected via digital loop-mediated isothermal amplification – a form of polymerase chain reaction (PCR). The developed system will be rapid, single use, portable and easy to operate – with no requirement for a highly specialised facility. It will also be compatible with other advanced downstream detection techniques and can be easily embedded into existing commercial kits or facilities to further improve the performance of detection techniques.

"This project builds on on-going projects at SMART focused on separating viruses and bacteria – which are much smaller than mammalian cells – from biological samples, and could revolutionise the way pathogens are identified," said **Dr Liu**. "The use of an efficient and relatively cost-effective method could significantly improve the prognosis of sepsis and other infectious diseases, and allow the delivery of timely and more personalised care."

The grants for these projects commenced on 1 April 2023 and will run for 18 months.

###

About Antimicrobial Resistance Interdisciplinary Research Group (AMR IRG)

The AMR IRG is a translational research and entrepreneurship program that tackles the growing threat of antimicrobial resistance. By leveraging talent and convergent technologies across Singapore and MIT, we aim to tackle AMR head-on by developing multiple innovative and disruptive approaches to identify, respond to, and treat drug-resistant microbial infections. Through strong scientific and clinical collaborations, our goal is to provide transformative, holistic solutions for Singapore and the world.

For more information, please log on to: http://amr.smart.mit.edu/#home

About Critical Analytics for Manufacturing Personalized-Medicine (CAMP)

CAMP is a SMART interdisciplinary research group launched in June 2019. It focuses on better ways to produce living cells as medicine, or cellular therapies, to provide more patients access to promising and approved therapies. The investigators at CAMP address two key bottlenecks facing the production of a range of potential cell therapies: critical quality attributes (CQA) and process analytic technologies (PAT). Leveraging deep collaborations within Singapore and MIT in the United States, CAMP invents and demonstrates CQA/PAT capabilities from stem to immune cells. Its work addresses ailments ranging from cancer to tissue degeneration, targeting adherent and suspended cells, with and without genetic engineering.

CAMP is the R&D core of a comprehensive national effort on cell therapy manufacturing in Singapore.

For more information, please visit: https://camp.smart.mit.edu/

About SMART Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP) [精准农业技术研究中心]

DiSTAP is one of the five Interdisciplinary Research Groups (IRGs) of the Singapore-MIT Alliance for Research and Technology (SMART). The DiSTAP programme addresses deep problems in food production in Singapore and the world by developing a suite of impactful and novel analytical, genetic and biomaterial technologies. The goal is to fundamentally change how plant biosynthetic pathways are discovered, monitored, engineered and ultimately translated to meet the global demand for food and nutrients. Scientists from Massachusetts Institute of Technology (MIT), Temasek Life Sciences Laboratory (TLL) and National University of Singapore (NUS) are collaboratively developing new tools for the continuous measurement of important plant metabolites and hormones for novel discovery, deeper understanding and control of plant biosynthetic pathways in ways not yet possible, especially in the context of green leafy vegetables; leveraging these new techniques to engineer plants with highly desirable properties for global food security, including high yield density production, and drought and pathogen resistance, and applying these technologies to improve urban farming.

The DiSTAP IRG at SMART is led by MIT co-lead Principal Investigator Professor Michael Strano and Singapore co-lead Principal Investigator from TLL, Professor Chua Nam Hai.

For more information, please log on to: https://smart.mit.edu/research/distap/about-distap

About Singapore-MIT Alliance for Research and Technology (SMART) [新加坡-麻省理工学院科研中心]

Singapore-MIT Alliance for Research and Technology (SMART) is MIT's Research Enterprise in Singapore, established by the Massachusetts Institute of Technology (MIT) in partnership with the National Research Foundation of Singapore (NRF) since 2007. SMART is the first entity in the Campus for Research Excellence and Technological Enterprise (CREATE) developed by NRF. SMART serves as an intellectual and innovation hub for research interactions between MIT and Singapore. Cutting-edge research projects in areas of interest to both Singapore and MIT are undertaken at SMART. SMART currently comprises an Innovation Centre and five Interdisciplinary Research Groups (IRGs): Antimicrobial Resistance (AMR), Critical Analytics for Manufacturing Personalized-Medicine (CAMP), Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP), Future Urban Mobility (FM) and Low Energy Electronic Systems (LEES).

SMART research is funded by the National Research Foundation Singapore under the CREATE programme.

For more information, please visit: http://smart.mit.edu/

For media queries, please contact:

Jo-Ann Teo
SMART@bluetotem.co
+65 9873 7794