

SMART's research in 2024: Pioneering Solutions to Address Societal Issues

In an era defined by rapid technological evolution and complex global challenges, the Singapore-MIT Alliance for Research and Technology (SMART) has continued to drive innovation that addresses some of the most pressing societal issues. From advancing sustainable technologies to revolutionising medical treatments, SMART combines MIT's globally renowned applied innovation methodology with Singapore's well-established R&D ecosystem to achieve market-ready breakthroughs.

Here, we delve into some of the notable breakthroughs and initiatives SMART has spearheaded in 2024:

Mens, Manus and Machina (M3S): Shaping the Future with AI and Robotics

Launched in 2023, the M3S Interdisciplinary Research Group (IRG) is on a mission to reimagine the role of AI, automation, and robotics in everyday life. The IRG has since published several papers and hosted several forums, seminars, and workshops to engage with the broader research community and industry partners.

Economic Gains Through Strategic EV Charging

M3S researchers conducted a study highlighting the economic advantages of strategically placed Electric Vehicle Charging Stations (EVCS). This research not only emphasises their environmental benefits but also demonstrates their role in stimulating local business growth, especially in underserved areas. These insights can potentially be instrumental in designing sustainable urban infrastructure that supports both commerce and clean transportation.

MIT-Singapore AI Symposium in [January](#) and [July](#) 2024

In 2024, M3S hosted two MIT-Singapore AI Symposiums, themed "How AI Empowers People, Institutions and the City" and held on 10 January 2024 and 10 July 2024. Bringing together global experts to discuss AI's transformative impact on individuals, institutions, and cities and promote the practical application of AI and machine technologies as extensions of human capabilities in today's society, the symposiums also explored how technology can empower communities, foster inclusion, and create resilient urban ecosystems.

Critical Analytics for Manufacturing Personalized-Medicine (CAMP): Medical Frontiers - A Leap in Personalised Treatments

SMART's CAMP IRG focuses on innovations to improve the production of cellular therapies to increase patient access to approved and promising treatments by addressing key challenges in cell therapy manufacturing: critical quality attributes (CQA) and process analytic technologies (PAT), demonstrated on

two prototypical cell therapy types - stem cells and T-cells for adoptive immunotherapies. Technologies and innovations include novel analytical tools that measure cellular attributes that correlate with therapeutic efficacy, rapid analytical tools that allow quick detection of bacteria, fungi or virus contamination during production, and processes that enable scalable manufacturing of often scarce cells for clinical use.

[Establishing stem cell biophysical quality attribute for cartilage repair](#)

In a potentially industry transformative manner, CAMP innovated on how bone-marrow derived mesenchymal stromal cells (MSCs) and chondrocytes for cartilage repair can be used more for more efficacious treatment of damaged joints through the (i) identification of a candidate efficacy CQA that is label-free (translating into minimal manipulation of cells and lowering cost), and (ii) development of a culturing method that preserves the desired cellular phenotype throughout the production process. Together, these innovations have the potential to significantly improve the efficacy of MSCs and chondrocytes for cartilage repair. Indeed, in vitro, proof-of-concept and proof-of-value preclinical studies have demonstrated encouraging results. The CAMP team, in collaboration with NUS Tissue Engineering and the Department of Orthopaedic Surgery, NUH, are planning on the next steps to validate human cells, as well as improve the quality and regulatory compliance of the innovations for clinical trials.

[Streamlined Cancer Therapies](#)

There are seven CAR T-cell therapies already approved by the USFDA, and they continue to be a promising cancer treatment for other cancer types. However, several key factors hinder patient accessibility, such as a lack of scalable manufacturing, which could drive costs down. CAMP's demonstration of a manufacturing process that allowed for intensified CAR-T manufacturing at doses that are similar to or near clinical doses brings about the feasibility of scaling out manufacturing of autologous CAR-Ts. This development leverages an MIT-developed microfluidic chip-based microbioreactor that is modular (thus allowing multiple patients' cells to be manufactured simultaneously) and has a small footprint that enables the consumption of smaller amounts of reagents used for cell production. When translated into a compliant ready platform, this innovation has the potential to increase production throughput, reduce costs and broaden access to patients, especially paediatric patients who have low or insufficient T-cell numbers to produce therapeutic doses of CAR T-cells. This innovation underscores the feasibility of more decentralised CAR T-cell production. CAMP is working with its regulatory and clinical partners to bring this vision to fruition.

Antimicrobial Resistance (AMR): Decoding Antimicrobial Resistance

SMART's AMR IRG focuses on addressing the growing threat of antimicrobial resistance by developing multiple innovative and disruptive approaches to identify, respond to, and treat drug-resistant microbial infections.

[Drug Resistance in Malaria Parasite](#)

SMART researchers made strides in understanding how malaria parasites develop resistance to drugs, uncovering mechanisms tied to tRNA modifications. This discovery provides a vital foundation for developing new antimalarial treatments, addressing a critical global health issue.

The 9th Princess Chulabhorn International Science Congress

In December, senior members of the SMART AMR IRG congregated in Bangkok to present their work at The 9th Princess Chulabhorn International Science Congress focused on One Health and Antimicrobial Resistance. Presenters and attendees including representatives from the United States Food and Drug Administration (US FDA), Thai Food and Drug Administration (Thai FDA), Tufts University, the Massachusetts Institute of Technology (MIT), the Chulabhorn Research Institute (CRI), the National University of Singapore (NUS), Nanyang Technological University (NTU), discussed regional collaboration, cooperation, and frameworks to improve access to essential drugs across Southeast Asia. The SMART AMR team left with actionable insights and a renewed drive for increased collaboration in Singapore and the region.

Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP): Sustainable Farming for a Growing World

SMART's DiSTAP IRG focuses on tackling food security challenges through innovative research and technology - towards a future where farmers can attempt to control how plants grow and improve conditions on the fly.

[A Breakthrough in Drought Detection](#)

DiSTAP researchers developed the world's first Covalent Organic Framework (COF) sensors embedded in silk fibroin (SF) microneedles to detect drought stress in plants. These minimally invasive sensor microneedles allow farmers to address plant dehydration before it affects crop yield, marking a significant leap forward in sustainable agriculture.

[Tracking Plant Stress Hormones](#)

DiSTAP has also developed nanosensors that detect salicylic acid, a key indicator of plant stress, in living plants alongside other hormonal signals simultaneously. This capability to multiplex different sensors allows for precise, real-time insights into crop health, enabling proactive farming strategies that promote sustainability.

SMART's achievements in 2024 reflect its unwavering dedication to addressing humanity's most critical challenges. By fostering interdisciplinary collaboration and blending cutting-edge technology with practical applications, SMART continues to build a future where innovation drives progress and resilience.