



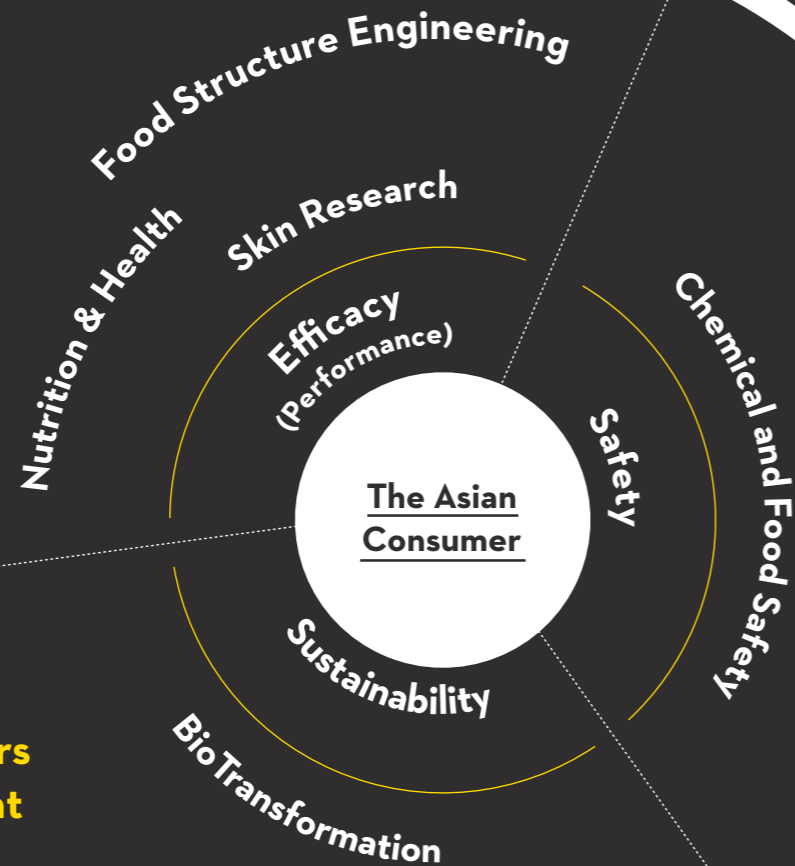
**SINGAPORE:
THE ASIAN
INNOVATION
CAPITAL FOR
**FOOD AND
CONSUMER
CARE****



Agency for
Science, Technology
and Research

PARTNERING FOR INNOVATION

Mapping innovation drivers to create industry-relevant programmes



Dr Kenneth Lee
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Dear colleagues,

Singapore is rapidly evolving into a science and innovation hub for food and consumer care. Over the last few years, global giants of the food and consumer care industry have either established or expanded their R&D centres in Singapore.

Companies tell us that, aside from being located at the epicentre of one of the world's fastest growing markets, one of Singapore's major attractions is the innovation ecosystem that is taking shape.

This is most evident in an area measuring only two square kilometres: one-north. Home to A*STAR, one-north is now a unique innovation hotspot for global brand owners, their ingredients partners, small enterprises, service providers and contract research organisations.

This vibrant ecosystem is underpinned by A*STAR—Singapore's lead agency for innovation-oriented research—with its 4,200 scientists and engineers, as well as Singapore's top-ranked institutes of higher learning and industry-focused polytechnics, which provide a source of talent for companies.

At A*STAR, we have deep capabilities or 'verticals' which span the breadth of the life sciences, chemistry, modelling and engineering.

When we set out about four years ago to increase our relevance to the food and consumer care industries, we chose to target our investments in three dimensions: efficacy, safety and sustainability.

Our multidisciplinary programmes or 'horizontals' address each of these dimensions, drawing on all of

the verticals for capabilities, tools and assets, and combining them in unique ways that you will not find in traditional academic institutions.

To enrich the ecosystem further, we have started partnering with venture capital firms to seed innovation and entrepreneurship.

For the food and consumer care industry, an ecosystem of this breadth and depth in a small physical location is unique in the world.

Brand owners and their innovation partners are co-creating and co-developing products for global markets out of Singapore. Being located on the same campus facilitates collaboration and enables different expertise to 'collide', opening up a world of new possibilities for innovation. Our strength truly lies in our ability to integrate.

So why not come to Singapore? We can do great things together.

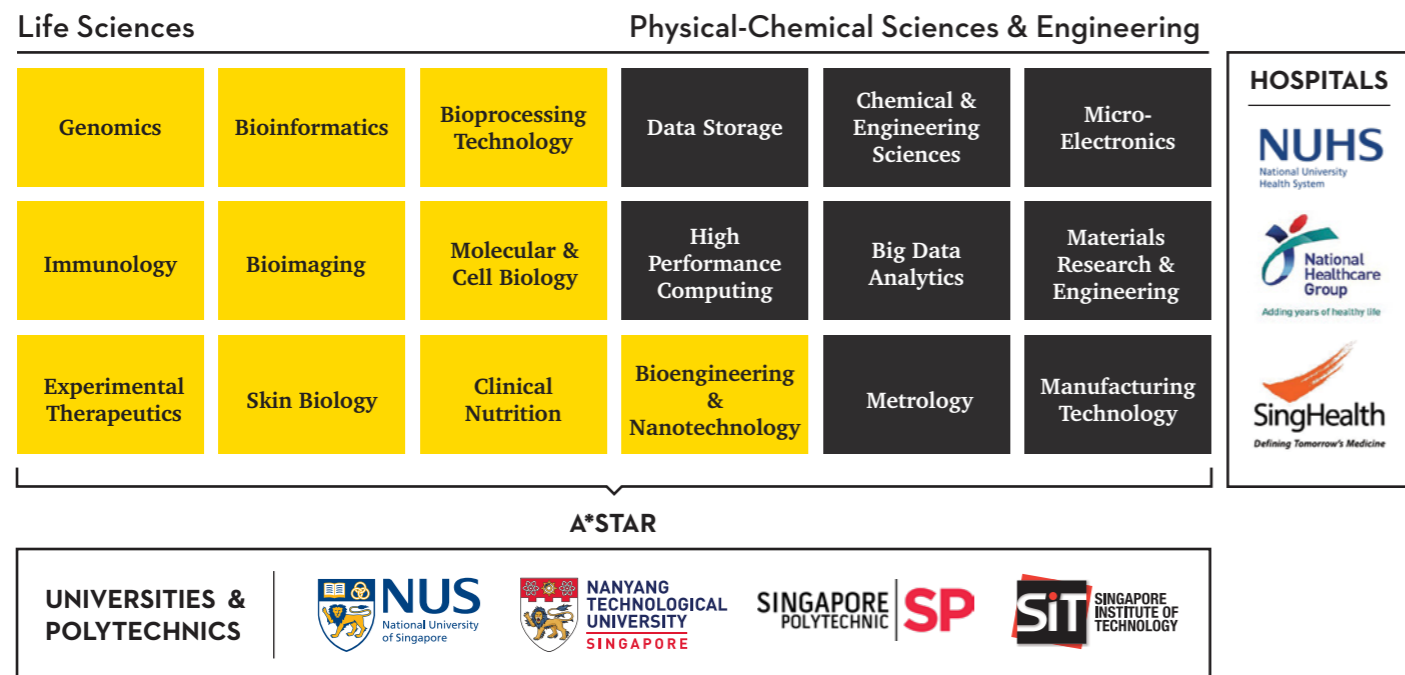
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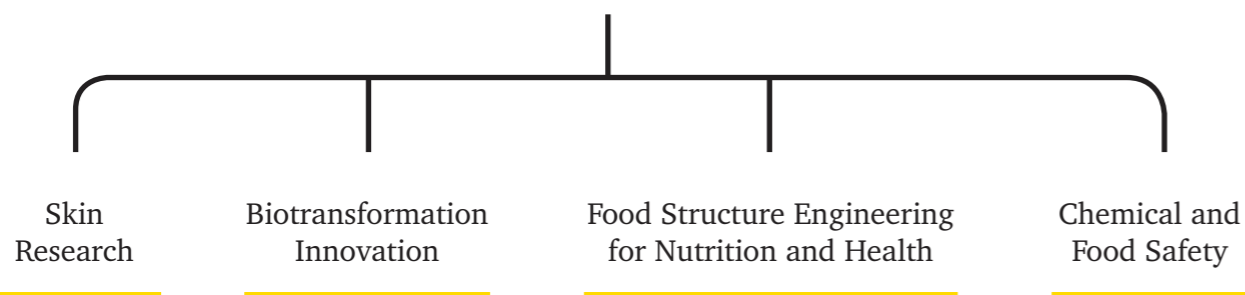
A*STAR

COLLABORATION & ECOSYSTEM

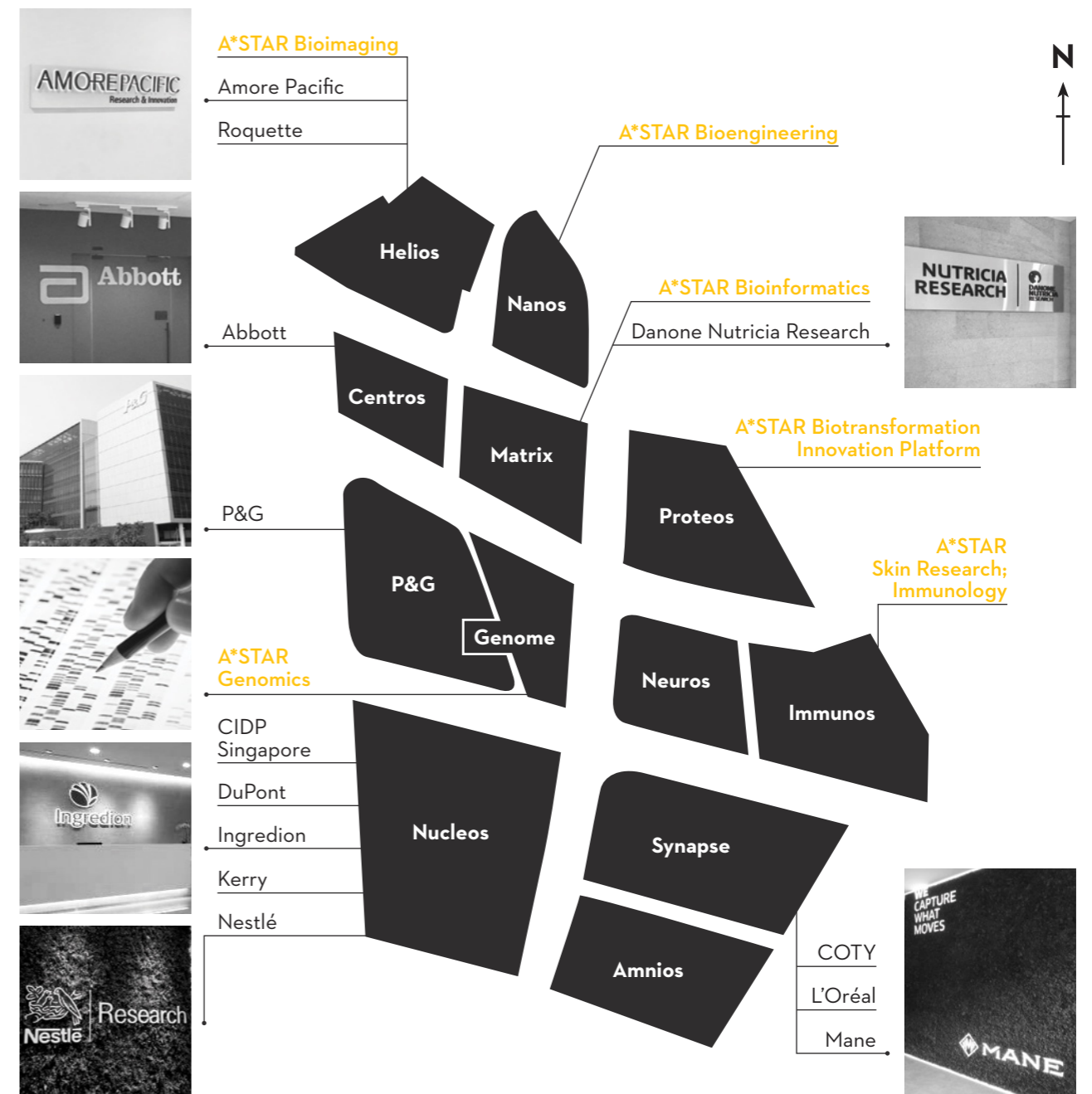
Agility in integrating from a deep pool of scientific capabilities...



... to create industry-relevant programmes



The Biopolis of Food and Consumer Care



Nearby Biopolis:

- National University of Singapore
- Singapore Polytechnic
- A*STAR research institutes at Fusionopolis
 - A*STAR High Performance Computing
 - A*STAR Materials Research and Engineering
 - A*STAR Big Data Analytics
- A*STAR Clinical Nutrition

NUTRITION THROUGH THE LIFE COURSE

CAPABILITIES

HUMAN NUTRITION

Asia's stellar economic growth has driven affluence and boosted purchasing power, turning the region into a key market for food companies. Yet, when it comes to nutrition, little is known about how Asian populations respond physiologically to foods.

Our human nutrition research programme will provide the insights necessary for

- Renovating and innovating foods, historically manufactured for Western markets, to now cater to the Asian palate; and
- Understanding the Asian metabolic phenotype, and how foods can be used to address metabolic conditions such as diabetes and obesity.



“The metabolic responses of Asians to foods eaten in Asia are significantly different from those of Caucasians. This necessitates the need to study Asian foods in Asians, in order to develop food-based interventions for health and wellbeing. We wish to see food as the new medicine.”

– Prof Jeyakumar Henry, Director, Clinical Nutrition Research Centre

Food structure and human nutrition

Eating is a pleasurable experience, but the foods of the future will need to provide much more in terms of functionality for health and nutrition. Our research seeks to understand how food components—proteins, fats and carbohydrates, for example—interact to produce physical, chemical, sensorial and nutritional properties, and hence to design foods with unique nutritional advantages.

CASE STUDY

Making coconut oil healthier

Coconut oil is widely used in Asian cooking, but is extremely high in saturated fat. A*STAR researchers, led by Prof Jeyakumar Henry, explored a potentially healthier but equally flavourful alternative: the use of coconut oil in the form of a semi-solid substance called an oleogel. Study participants who ate rice porridge mixed with coconut oleogel had lower peak blood triglyceride levels after their meals as compared to those who ate theirs with coconut oil.

“This study shows how changing the structure of food—the alteration of coconut oil into a gel—completely alters its metabolic properties,” said Prof Henry.

HUMAN NUTRITION

Functional foods for health promotion

A*STAR researchers are investigating the ability of functional foods to promote health and prevent obesity-associated diseases such as hypertension and diabetes. Such foods present non-pharmacological alternatives that are more sustainable, acceptable and scalable to large populations. Our research focuses on the impact of functional foods on biochemical and physiological pathways, and the mechanisms by which regular consumption of these foods could lead to long-term metabolic benefits.

CASE STUDY

Harnessing the power of BAT

Brown adipose tissue (BAT) constitutes a miniscule fraction of our bodyweight, but has the capacity to burn large quantities of ingested calories and to store metabolically unhealthy fats. Foods that harness the fat-burning power of BAT thus present alternative methods for controlling obesity, in addition to diet and exercise.

Using non-invasive infrared thermography, researchers led by Associate Prof Melvin Leow found that capsinoids (non-spicy variants of the capsaicin found in chilies and peppers) were able to activate BAT in a group of young male adults. The team is now incorporating other imaging methods—namely 18F-FDG PET scans and fat fraction MRIs—to better understand how this activation occurs.

**Body composition and metabolic health**

Our researchers are examining ways to use functional foods to control body weight, by increasing metabolic rate through activation of brown and beige fat. They are also studying how nutrition and exercise impact metabolic diseases such as obesity, type 2 diabetes and lipid disorders.

CASE STUDY

Understanding the Asian metabolic phenotype

Metabolic conditions such as hypertension and insulin resistance are highly prevalent in Asian populations, even among people considered 'lean' by conventional measures. Dr Faidon Magkos is using techniques such as magnetic resonance imaging and magnetic resonance spectroscopy to study the mechanisms responsible for this 'metabolically unhealthy lean' phenotype. To develop interventions, the researchers are also working to understand how diet and exercise affect metabolism in such individuals.

"Individuals with this phenotype are more likely to go undiagnosed in standard clinical practice, and are thus less likely to be treated before clinically overt cardio-metabolic disease develops. By facilitating earlier identification of these subjects, these studies will allow for earlier and more effective intervention," said Dr Magkos.

HUMAN NUTRITION

Behavioural insights and sensory perception

We can design the healthiest foods ever, but it will mean little if people don't select and consume them. Our researchers are working to understand the fundamental processes behind how people think about and select food, as well as how socioeconomic disparities influence appetite and food preferences. Their goal is to develop food-based solutions to improve food choice and eating behaviours for better health.

CASE STUDY

What's in a bowl?

To examine how sensory perception affects eating behaviour, A*STAR researchers led by Associate Prof Ciaran Forde served identical-looking bowls of ramen—but with wildly differing calorie densities—to study participants. Participants who ate low-calorie bowls for lunch did not eat more at dinner, suggesting that they did not feel the need to compensate as long as their senses told them that they had not been short-changed.

“Food aroma stimulates specific appetites, taste signals the arrival of nutrients, and texture influences how quickly we eat. Our goal is to use these sensory properties to promote healthy food intake behaviours,” said Associate Prof Forde.

CASE STUDY

The socioeconomic food chain

The mere experience of feeling socioeconomically inferior to others is enough to provoke behaviours that could lead to obesity, according to a study co-authored by A*STAR researcher Dr Bobby Cheon.

To alter their experience of social status, study participants were shown an image of a ladder and asked to compare themselves to people at the top or bottom. Participants who were made to feel socially inferior were more likely to associate foods such as pizza and fried chicken with pleasant words, showing that they subconsciously preferred high-calorie foods.

“Interventions targeting obesity among people of lower socioeconomic means may need to address these psychological factors, in addition to facilitating access to healthier diets,” said Dr Cheon.



TWEAKING CALORIES

- | | |
|--|---|
| <p>1 Ramen Noodle
Replaced with spiralised courgette</p> <p>2 Ramen Broth
Mixture of dashi broth and soy bean paste, with varying amounts of canola oil and maltodextrin</p> <p>3 Chicken
Fried chicken replaced with baked chicken</p> | <p>4 Sesame Seeds
Varied in quantity</p> <p>5 Beansprouts and Spring Onions
Low energy components were kept constant across all meals</p> <p>6 'Narutomaki'
Japanese fishcake; varied in thickness</p> |
|--|---|



MATERNAL AND INFANT NUTRITION

Growing Up in Singapore Towards healthy Outcomes (GUSTO)

GUSTO, a nation-wide birth cohort study, aims to understand how lifestyles and diets in pregnancy and during early childhood influence the health and development of women and children.

Researchers followed more than 1,200 Singaporean women volunteers during and after their pregnancies; their babies were also followed closely as they grew up. Their findings address issues such as nutritional supplementation and child cognitive performance, child body composition and obesity risk, child mental health, gestational diabetes, and pre-term labour.

“Our findings have already led to a change in clinical practice around gestational diabetes in Singapore, and we hope to extend our findings to improve the management of maternal emotional health and child school readiness,” said Prof Chong Yap Seng, GUSTO’s lead principal investigator.

GUSTO has attracted collaborations with industry partners, including Nestlé, Abbott and Danone Nutricia Research.

CASE STUDY

Nipping gestational diabetes in the bud

A 2014 GUSTO study found that gestational diabetes mellitus (GDM)—a temporary condition that occurs during pregnancy—was much more common than previously thought, affecting up to one in five women. GDM can lead to health risks, including premature birth and high infant birth weight.

Based on the GUSTO study, hospitals are now beginning to implement universal screening and lifelong post-diagnosis follow-up, to provide an early window of opportunity to improve the long-term health of mother and child.

“This screening will help expectant mothers with GDM manage their condition during pregnancy. They should also be followed up long-term by their general practitioners as they are at higher risk of developing Type 2 diabetes,” said Dr Cai Shirong, who led the study.

PARTNERSHIPS

Detecting early-life biomarkers for allergic disease

Researchers are also using data from the GUSTO study to identify potential early-life microbial biomarkers of allergic disease. Their work provides insights into microbial signatures associated with the development of early childhood allergies, and in particular indicates a potential link between *Klebsiella/Bifidobacterium* ratio and allergic disease.

This study is a collaboration between researchers from A*STAR, the National University of Singapore and KK Women’s and Children’s Hospital, with Danone Nutricia Research as an industry partner.

CASE STUDY

Epigenetic marks influence obesity risk

Epigenetic modifications to DNA such as methylation alter the activity of genes without changing the actual DNA sequence.

GUSTO researcher Dr Clara Cheong’s team found that lower DNA methylation levels at the CDK2A gene (which regulates the production of fat cells) at birth were associated with an increased risk of obesity later on in life. These findings lay the groundwork for trials of nutritional interventions before and during pregnancy that could reduce babies’ risk of obesity in childhood and later life.



Pregnant mummy at the GUSTO launch



Taking a buccal swab sample



Conducting the School Readiness Test at age four

MATERNAL AND INFANT NUTRITION

Singapore PREconception Study of long-Term maternal and child Outcomes (S-PRESTO)

The first study of its kind in Asia, S-PRESTO aims to understand how a woman's health, nutritional and emotional state before pregnancy can influence both maternal and child health. Researchers are studying 1,000 couples who are actively planning pregnancy, collecting information from the time they plan to conceive, to successful conception, and up until their child is two years old.

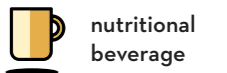
Data from this cohort will be critical for prevention and intervention strategies and clinical guidelines to reduce the risk of metabolic and mental diseases, and to ensure healthy childhood development.



NiPPeR (Nutritional Intervention Preconception and during Pregnancy to maintain healthy glucosE levels and offspRing health)

A*STAR researchers and collaborators in the UK and New Zealand are working with the Nestlé Research Centre to study how pre-conception nutrition affects maternal and child health.

The NiPPeR study will follow 1,800 women who will consume a nutritional beverage (containing vitamin and mineral supplements already recommended for pregnancy) twice daily, both before and during pregnancy. By gathering new insights into the long-term effects of pre-conception nutrition, the researchers hope to potentially improve pre-natal care.



1,800 women



To study the long-term effects of pre-conception nutrition



CAPABILITIES

BIOTRANSFORMATION INNOVATION

A*STAR's Biotransformation Innovation Platform (BioTrans) harnesses the power of microbes to address the needs of the food, flavour and fragrance, and personal care industries.

The platform develops microbial fermentation-based processes to impart signature flavours and functional benefits to food, produce high-value compounds sustainably, and convert food industry side streams into value-added products. It also leverages A*STAR's Natural Product Library (NPL), which comprises more than 300,000 extracts derived from microbial, fungal and plant specimens.

"BioTrans has established state-of-the-art technology as well as a holistic vision that makes it unique in its field," said Dr Nic Lindley, BioTrans Director. "Using novel downscaling techniques to mimic real industrial constraints, BioTrans has the capacity to drive research from discovery to scalable processes."

PARTNERSHIPS

Nestlé and A*STAR team up on biotransformation

Nestlé's biotransformation platform at the company's R&D Centre in Singapore was set up in 2014 in collaboration with A*STAR. Nestlé and A*STAR scientists have since worked together to improve nutrient yields obtained from raw materials—such as barley—during Nestlé's malt extraction process, thus helping the company further its commitment to environmental sustainability.

"A*STAR's biotechnological capabilities and expertise have been instrumental in achieving these results. We are looking forward to scaling up the process for implementation in Singapore and, in the future, exploring opportunities in other markets as well," said Dr Jeroen Muller, Group Leader, Science & Technology (Biotransformation), Nestlé R&D Centre Singapore.



BIOTRANSFORMATION TECHNOLOGY PLATFORMS

Discovery

CASE STUDY

A taste for the novel

BioTrans' automated taste receptor screening platform uses unique cell-based molecular assays to identify novel tastants and modulators. Combining these assays with *in silico* models also allows pre-screening and targeted prediction of chemical compounds, which accelerates the discovery process.

"The uniqueness of our platform lies in A*STAR's proprietary non-viral gene delivery technology, which introduces taste receptor genes—of varying complexity and in different combinations—with exceptional efficiency. This allows us to identify active taste substances in a high-throughput manner," said Dr Too Heng Phon, the platform's lead investigator.

Microbial population and strain optimisation

CASE STUDY

Putting evolution to work

BioTrans researcher Dr Giulia Rancati uses evolutionary strategies to generate microbial strains that can produce industrially relevant compounds under the extreme stress conditions of large-scale industrial fermentation.

"Nowadays, consumers demand and are willing to pay high prices for non-GMO products. It is therefore extremely appealing for companies, especially in the food and flavour sector, to have access to naturally evolved, non-GM strains that are capable of producing relevant products at industrially pertinent yields," said Dr Rancati.

Dr Andrea Camattari applies population engineering to naturally improve fermentation processes for flavour development. "A natural, non-GMO approach to significantly modify product features using knowledge-based population engineering is a natural extension to our approach at BioTrans," said Dr Camattari.

Together with collaborators, Dr Rancati and Dr Camattari are optimising fermentation strategies to maximise flavour production in food industry processes, as well as using microbial genomics techniques to create multi-species starter cultures that impart specific characteristics.

Fermentation and downstream processing

CASE STUDY

Cellular plug-and-play

BioTrans' cell factory platform combines metabolic engineering, synthetic biology and fermentation techniques to optimise the production of target molecules. Projects here include a modular plug-and-play platform for optimised apocarotenoid production; novel fungal terpene synthases to produce flavour and fragrances; and a yeast-based platform to produce lipid-derived flavour compounds.

"Within BioTrans, experts in metabolic engineering and fermentation work closely together. Strain improvement can reduce the cost of large-scale bioprocessing, and conversely, bioprocess design and evaluation takes place with the characteristics of the target strain in mind. This approach shortens the time-to-market," said Dr Yvonne Chow, a team member of BioTrans.

CAPABILITIES

SKIN RESEARCH

SKIN RESEARCH INSTITUTE OF SINGAPORE

The Skin Research Institute of Singapore (SRIS) brings together A*STAR's strengths in skin biology, the National Skin Centre's (NSC) expertise in clinical dermatology, and Nanyang Technological University's (NTU) capabilities in bioengineering, nanotechnology and materials science.

With a focus on Asian skin and skin health in the tropics, SRIS aims to establish itself as the global partner of choice for companies looking for opportunities in the fast-growing Asian skin health market.

SRIS's research falls under two multidisciplinary themes: skin integrity, repair and regeneration; and skin inflammation, infection and immunity.

SRIS is led by Executive Director Prof Steven Thng, a senior consultant at NSC with more than 15 years of experience in dermatology, and Chief Scientist Prof Birgit Lane, SRIS co-founder and a thought leader in the field of skin research.

Developed by A*STAR's Prof Malini Olivo, this handheld probe uses multispectral optoacoustic tomography (MSOT) technology to image hair follicles, sebaceous glands and carcinomas

“Singapore, through A*STAR and its top academic institutions as well as deep investment in top talent and infrastructure, has created one of the most vibrant and innovative scientific ecosystems in the world.”

– Mr Mark Phong, L'Oréal R&I Asia Director,
Advanced Research Labs & Business Development

PARTNERSHIPS

A*STAR scientists team up with L'Oréal against skin aging

Cosmetics giant L'Oréal is working with A*STAR's Dr Colin Stewart and Dr Oliver Dreesen to study the mechanisms behind skin aging, as well as to evaluate compounds that could target this process and delay its onset.

Dr Stewart works on the lamin-A protein, a mutant form of which is involved in progeria, a disease of premature aging, while Dr Dreesen studies the role of telomere dysfunction and cellular senescence in progeria as well as in normal human aging.

“L'Oréal is happy to be part of this vibrant ecosystem, where we have benefited from working closely with some of the world's top experts to advance our knowledge in the areas of skin aging and hair biology, leading to the future development of cutting-edge consumer care products to better serve our customers, especially in Asia,” said Mr Mark Phong, L'Oréal R&I Asia Director, Advanced Research Labs & Business Development.

“Singapore, through A*STAR and its top academic institutions as well as deep investment in top talent and infrastructure, has created one of the most vibrant and innovative scientific ecosystems in the world,” continued Mr Phong.





SKIN RESEARCH INITIATIVES

National Programme on Atopic Dermatitis

Atopic dermatitis (AD) or eczema is characterised by episodes or areas of inflamed, often infected skin, and represents a large clinical burden in Singapore. The phenotype of AD in Asians is significantly different from that of Caucasians, with disease severity particularly pronounced. This National Programme takes a systems biology approach towards understanding the pathogenesis of Asian AD, mapping genetic, epigenetic, metagenomic, immunological and imaging profiles to clinical severity.

The programme's aims include discovering and validating novel therapeutic targets in physiologically relevant disease models; developing new diagnostics for routine clinical use; and enhancing patient compliance through gamification and mobile apps.

CASE STUDY

Exploring the ecology of eczema

Dr John Common and Dr Niranjan Nagarajan pioneered the first application of whole metagenome shotgun sequencing of AD patients' skin to explore how the skin microbiome interacts with the immune system and skin microenvironment to contribute to AD flare cycles. AD patients were found to have fundamentally different skin microbiome compositions from people with healthy skin. Using high-resolution metagenome analysis, the researchers identified functional gene pathways that link to potential novel intervention points.

"Our work on AD suggests that interventions targeting the skin microbiome with probiotic microbe transplants or metabolite production could be useful for preventing skin diseases. Additionally, AD-specific skin microbiome profiles could be useful as a diagnostic tool when classifying this heterogeneous disorder," said Dr Common. "We are now focusing on longitudinal clinical studies across AD flares, microbiome development in infants at high risk of developing AD and studying the various differential strains of microbes that we have identified."

The Sebaceous Gland Lab

Led by Dr Lim Xinhong and Dr Maurice van Steensel, the Sebaceous Gland Lab (SGL) aims to develop innovative products to control the highly prevalent conditions of acne and dry or oily skin that result from sebaceous gland dysfunction.

To do this, the SGL integrates cutting-edge basic science and comprehensive clinical testing in Asian populations to elucidate the molecular mechanisms behind acne development and sebum production. First-in-class technologies such as advanced, physiologically accurate *in vitro* and *in vivo* models for acne and sebaceous gland biology as well as non-invasive skin imaging enable the discovery and testing of actives in large, well-characterised cohorts of Asian young adults. These approaches have led to the identification of novel compounds that are entering clinical testing for the treatment of common skin conditions.

Wound care innovation for the tropics

Led by Dr Zee Upton, this programme is the first in the world to focus on wound care in the tropics and in Asian populations, taking into account the region's unique challenges of humidity, infection, genetic factors, pigmentation and service delivery.

By developing novel tools, devices, dressings and therapies, the programme's goals include achieving better stratification between healing and non-healing wounds through biomarker identification; finding better ways to treat both healthily colonised and infected wounds; and stimulating healing with a shorter time to wound closure. A suite of 20 ongoing technology-proving and proof-of-concept projects is expected to deliver interesting applications, such as print-to-fit smart dressings and smartphone devices for wound diagnostics and tracking. A Singapore-wide wound registry will also be established to enable better clinical monitoring and testing of interventions. With an integrated approach spanning clinical applications, engineering, infocomms technology and the biological sciences, the programme aims to position Singapore as the go-to hub for wound product R&D.

Countering environmental stresses

Hyperpigmentation or skin darkening occurs as we age, and is exacerbated by exposure to environmental stresses. With a view to developing treatments to control hyperpigmentation, Dr Carlos Clavel and Dr Oliver Dreesen are using novel melanocyte-keratinocyte co-culture systems to model and quantify the effects of ageing, air pollution and UV radiation on melanin production and pigment transfer. *In vitro* cellular models will be challenged with airborne pollutants such as polycyclic aromatic hydrocarbons (PAHs) and PM1, 2.5 or 10 in concentrations relevant to human exposure, using both environmental chambers and direct application in solution.

SKIN RESEARCH TECHNOLOGY PLATFORMS

Skin Health Monitoring Centre

The Skin Health Monitoring Centre houses state-of-the-art infrastructure for non-invasive imaging and characterisation of skin and hair. With access to well-phenotyped healthy and patient cohorts across different life stages, the Centre allows for in-depth profiling of the skin to understand the incidence, severity and burden of sub-clinical and clinical disease. The suite of capabilities also supports clinical testing, personal care innovation, device development and drug discovery.

CASE STUDY

Looking beyond skin-deep

A*STAR's Prof Malini Olivo has developed a non-invasive, pain-free multispectral optoacoustic tomography (MSOT) method for imaging hair follicles and sebaceous glands in 3D. The technique combines high-resolution, real-time ultrasound detection with the specificity of optical contrast. In addition to visualising hair follicle morphology, the technology can also quantify levels of melanin, lipids, as well as water and oxygenation levels in the circulation. This technology, encased in a highly versatile handheld probe, was developed in collaboration with iThera Medical, a leader in next-generation molecular imaging.

Asian Skin and Tissue Biobank

The Asian Skin and Tissue Biobank is a globally unique collection of cell, tissue and other skin-related material from Asian populations. The resource comprises material from nine Asian ethnicities spanning the ages of 2–89 years, a range of body sites (sun-exposed and unexposed), and multiple isolated components including melanocytes from dark and light skin, hair follicles and dermis layers.

The Biobank also focuses on developing advanced skin tissue modelling and reconstruction techniques, such as 3D organotypic models and skin-microbe co-cultures, as well as chambers simulating environmental exposure. These resources support new research fields, including toxicology testing, regenerative medicine, disease modelling, and environmental stress and pollution studies.

Skin Immunomonitoring Platform

The Skin Immunomonitoring Platform uses advanced genomic, proteomic and cell-based assays to provide a complete picture of the human immune response in a tissue over the course of disease or therapy. The data can then be mined for new insights into inflammatory conditions such as atopic dermatitis, with the potential to generate new targets for disease management.



CASE STUDY

From bench to market

In 2009, A*STAR's Dr Bruno Reversade and his team linked the PYCR1 gene—which encodes a protein that controls reactive oxygen species levels—to a group of hereditary 'pro-geriatric' disorders known as autosomal recessive cutis laxa (ARCL). ARCL patients suffer from wrinkled skin and weak bones from childhood.

Besides providing insights into the molecular basis of ARCL, this study also turned out to have commercial applications. Skincare conglomerate AmorePacific subsequently developed a product—the Laneige Perfect Renew Regenerator serum—based on this research.

“Highly-educated and well-informed consumers have a growing appetite for scientific facts and claims on our products. Through our collaboration with Dr Bruno Reversade at A*STAR, we were able to tap into their deep knowledge of medical biology. Together with our expertise in skin research, a star product was born.”

– Mr Simwook Young, Senior VP, R&D Management Division, AmorePacific R&D Centre

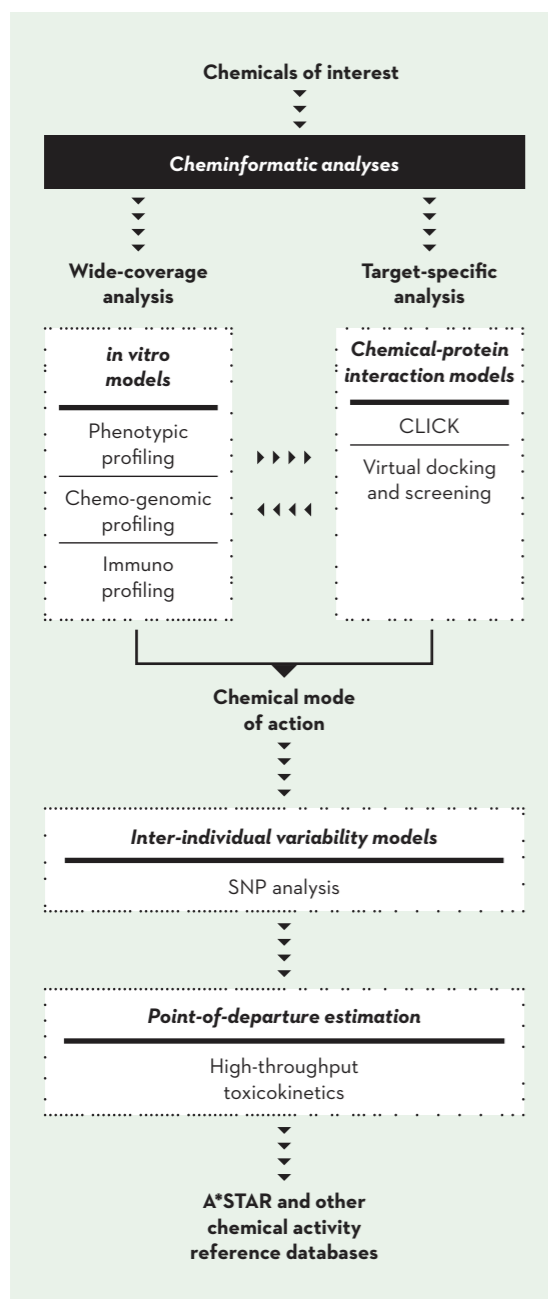
CAPABILITIES

INNOVATIONS IN CHEMICAL AND FOOD SAFETY

A*STAR's Programme in Innovations in Chemical and Food Safety aims to catalyse safe innovation activities in Singapore to capture the growing Asian consumer market.

To advance non-animal approaches to chemicals testing, A*STAR has developed a unique toolbox which integrates *in vitro* and computational methods, allowing researchers to unravel chemical modes of action and assess toxicological tipping points in an efficient and predictive manner.

In food safety, A*STAR is developing efficient, cost-effective screening technologies for detecting contaminants, creating intelligent supply chains and building up scientific expertise for risk assessment of novel food and food processes. In the area of contaminant detection, for example, researchers are integrating microfluidics and biosensor systems with low-cost diagnostics to enable rapid and targeted detection of food pathogens.



CASE STUDY

Toolbox for toxicity and mode-of-action prediction

The Toxicity Mode-of-Action Discovery (ToxMAD) platform is a suite of unique *in vitro* and *in silico* tools to elucidate the biological pathways underlying chemical toxicity. ToxMAD is built upon phenotypic profiling, developed by A*STAR researcher Dr Loo Lit-Hsin, which combines advanced processing of human cell microscopy images and data analytics to automatically identify quantitative and predictive toxicity markers. This allows chemicals to be screened rapidly and prioritised.

PARTNERSHIPS

International partnership for new risk assessment approaches

A*STAR is participating in an international case study with the US Environmental Protection Agency (EPA), the European Chemicals Agency (ECHA), the European Food Safety Authority (EFSA) and Health Canada to generate toxicity data on ingredients widely used in consumer care products or food additives, such as parabens. A*STAR works with EPA's National Centre for Computational Toxicology to use its ToxCast programme to develop and validate non-animal approaches for this.

"We are excited to combine our computational and toxicological expertise with the world-class biomedical research capabilities of A*STAR. Through this collaboration, we hope to develop more efficient and economical ways to evaluate the potential health effects of chemicals that can be used by both industry and government agencies," said Dr Russell Thomas, Director, EPA National Centre for Computational Toxicology.

CAPABILITIES

CONSUMER RESEARCH

Researchers in A*STAR's social and cognitive computing programmes are leveraging social media data to sense consumer sentiments, analyse customer demographics, and develop innovative e-business strategies.

SentiMo

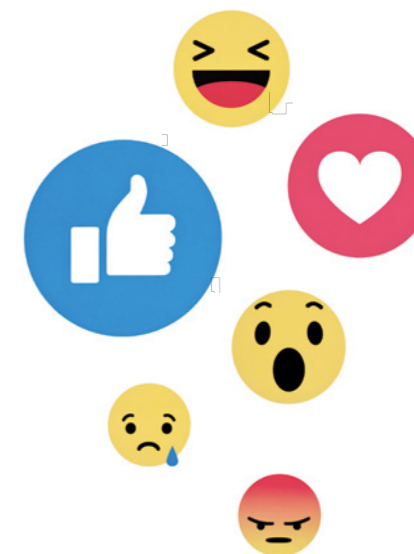
SentiMo, a tool developed by A*STAR's Institute for High Performance Computing (IHPC), automatically collects and classifies social media posts into sentiment categories (positive, negative, neutral or mixed, for example), and identifies their prevailing emotion (such as desire, satisfaction, anger or sadness).

"Organisations can pick up changes in patterns or behaviour on the ground early, anticipate and respond to change faster, and better understand and respond to customer needs. This enhances their marketing and public engagement capabilities," said Dr Victor Joo Chuan Tong, Director, Social and Cognitive Computing Department, IHPC. SentiMo is now available for use and commercial licensing.

CASE STUDY

Detecting ground-level sentiment

A*STAR researcher Dr Yang Yiping uses SentiMo, together with innovative algorithms and a comprehensive set of in-house dictionaries, to decipher emoticons, internet slang, colloquial expressions, and even Singlish (the patois spoken colloquially in Singapore) from public social media posts. This fine-grained sentiment and emotion analysis from text allows companies to perform market sensing and daily brand and product surveillance in a more productive and reliable way.





BUILDING THE INNOVATION ECOSYSTEM

Singapore's one-north area is home to a vibrant innovation ecosystem of brand owners, ingredients innovators, startups, venture capital firms and contract research organisations. Brand owners and their innovation partners are taking advantage of this hotspot of innovation to co-create and co-develop products for global markets out of Singapore.

PARTNERSHIPS

Getting smart about smart packaging

Despite the huge market potential of smart, sustainable packaging, not many local enterprises create such products.

A*STAR partnered Honsen Printing Industries, a local manufacturer of labels and stickers, together with Nestlé, and helped Honsen develop capabilities to design and manufacture smart packaging using printed electronics, for a new range of NESCAFÉ products in Thailand. The SME has since commercialised the technology and helped create a local supply chain in smart packaging.

"This collaboration was a great example of how working with a public institution and a local SME enabled Nestlé to rapidly progress from concept to prototype to launch in a short span of less than six months," said Dr Tan Sze, Managing Director, Nestlé R&D Centre Singapore.

PARTNERSHIPS

Better bacteria for babies

Babies delivered by caesarean section (C-section) have imbalanced gut microbiota compositions, and are more likely to develop allergies and become obese later in life. In a collaborative study, Danone Nutricia Research and Singapore's KK Women's and Children's Hospital found that Danone Nutricia's synbiotics (which contain beneficial microbes and ingredients needed to support their growth) compensated for the delayed colonisation by bacteria in C-section-delivered children, who developed gut microbiota emulating that in vaginally born children. This study facilitated the registration of Danone Nutricia's novel synbiotics in Singapore.

Danone Nutricia also worked with A*STAR to use next-generation DNA sequencing to characterise the composition of the infants' gut microbial communities. This data provides insights into how early life events impact infant gut microbiomes, and what can be done to mitigate health risks.

PARTNERSHIPS

Enabling local enterprises through collaboration

Golden Wheel Industries, a Singapore SME, has helped P&G to manufacture test batches of products since 2013. Through its collaboration with P&G, Golden Wheel's staff acquired skills in digital systems and automation, which increased manufacturing productivity and helped boost the firm's services to its other clients. Golden Wheel now has some 50 staff stationed at P&G's Singapore Innovation Centre.

"Flexibility, agility and the willingness to partner are some key traits that SMEs generally have, which counterbalances what a big multinational like P&G doesn't," said Mr James Kaw, Director of Corporate R&D, P&G Singapore.

CASE STUDY

CROs, a valuable resource

Contract research organisations (CROs) provide a valuable and affordable resource for industry research. CIDP Singapore, a private, independent CRO established in 2015, carries out high-performance research and clinical activities for the pharmaceutical, medical device, nutrition and cosmetics industries. Its expertise includes SPF testing and studies on hydration, skin lightening and brightening, skin firmness and wrinkles, and skin texture.

"Singapore was a logical choice for our Asia office because of its excellent infrastructure, transparency of requirements and regulations, and convenient access to Asian markets. We are confident that this new venture will bring CIDP to greater heights," said CIDP CEO Mr Jean-Louis Roule.

CASE STUDY

Catalysing startups

A*STAR also acts as a bridge to link startups to venture capital (VC) firms and catalyse growth in the local economy. In 2017, A*STAR co-organised the first Future Food Asia Awards with ID Capital, a Singapore-based VC and advisory firm.

Focusing on foodtech and agritech in Asia, the Awards was dedicated to startups from the wider Asia Pacific region that are creating solutions to tackle present and predicted issues in the food industry.

"World-class innovation in the agritech and foodtech sectors is very present in the region, and we will make sure that this innovation platform keeps growing over the coming years," said Ms Isabelle Decitre, founder of ID Capital.



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