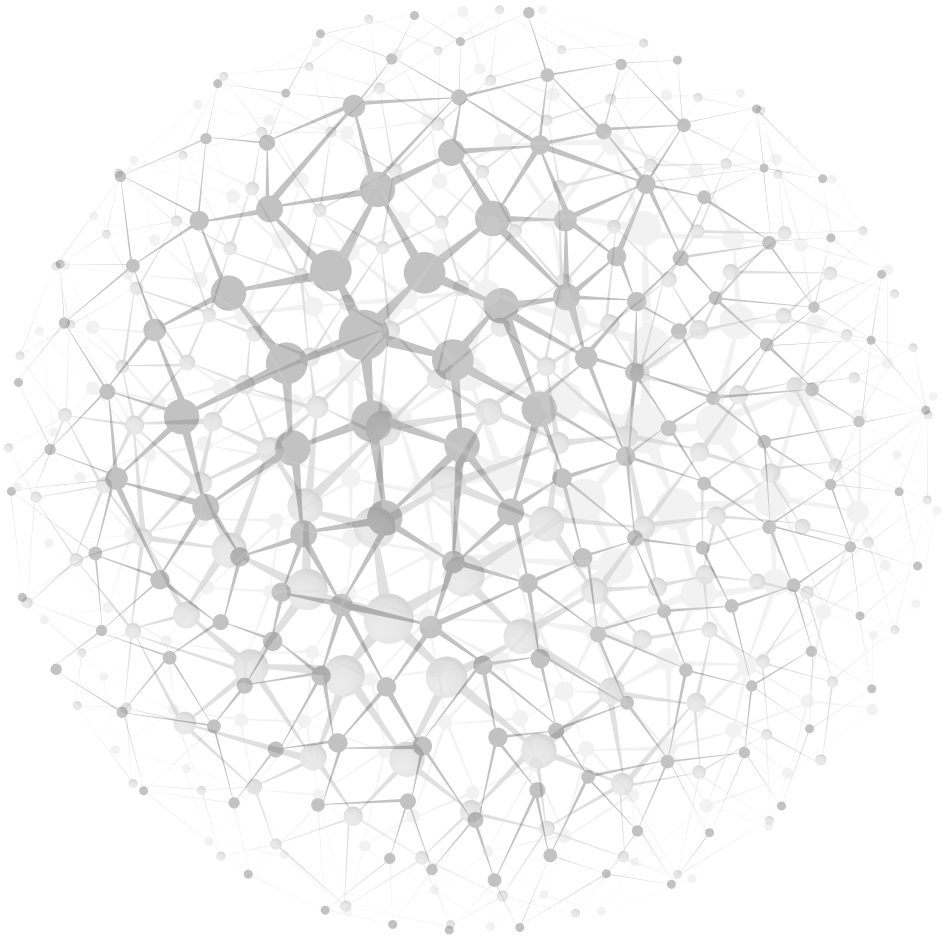
Biennial Report 2015

School of Applied Science



Education • Research, Innovation & Enterprise • Service

School of Applied Science (ASC)

Vision

To be a leading centre for training, education and applied research in the chemical and life sciences

Mission

To continuously seek innovative ways to train and educate school leavers and the workforce, and to carve niche applied research areas that will benefit students, industry and the community

“

Singapore’s long term aim is to be one of the most research-intensive, innovative and entrepreneurial economies in the world in order to create high-value jobs and prosperity for Singaporeans. Research and innovation underpin the competitiveness of our industries, catalyse new growth areas, and transform our economy.

Lee Hsien Loong
Prime Minister of Singapore

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Minister of State for Culture, Community & Youth, Mr Sam Tan with ASC students at the 'Singapour en France – le Festival' event in Paris

Ambassador-at-Large Prof Tommy Koh at the launch of ASC's 1st commemorative cookbook 'Singapore Hawker Classics Unveiled'

Senior Minister of State, Ministry of Home Affairs & Ministry of National Development, Mr Desmond Lee, at the 2015 ASC Show

Contents

Celebrating 16 Years of ASC

2000

Temasek Applied Science School (ASC) established - spun off from Temasek Information Technology and Applied Science School (ITAS)

Mrs Soon-Ong Meng Wan appointed Director of ASC

Four diploma courses - Applied Food Science & Nutrition, Biotechnology, Chemical Engineering, Consumer Science & Technology

Specialist laboratories - TP Hydroponics Greenhouse, Aquaculture Workstation, Food Preparation Laboratory, and Food Product Development Laboratory

2001

1st Glycemic Index testing of selected fruits and noodle varieties

1st School Advisory Committee

2002

Capability development in Traditional Chinese Medicine (TCM) Analysis

Diploma in Biomedical Science

2003

Hydroponics Orchid Growth System

2005

Institutional Animal Care and Use Committee

KoolWerkz Learning Enterprise

Laboratory Animal and Aquaculture Workstations expanded to include Lab Animal Workstation, forming Temasek Animal Facility

2006

Singapore's 1st low glycemic index bread formulated by Applied Food Science and Nutrition team

Temasek Applied Science Research Centre (AS4)

2007

Diploma in Baking & Culinary Science and Diploma in Veterinary Technology

Training unit for mass production of tissue culture plantlets

2008

Bistro Walk Learning Enterprise

2009

Culinary Laboratories - Asian, Bakery/Pastry and Western Kitchens

Diploma in Pharmaceutical Science

Glycemic Index Research Unit (GIRU)

Singapore Laboratory Accreditation Scheme (SINGLAS) accreditation for functional food testing, and chemical and biological testing

2010

Dr Lee Chee Wee appointed Director of ASC

2011

Temasek Applied Science School rebranded as Temasek Polytechnic School of Applied Science

TP Animal Clinic

2012

1st CET Diploma in Applied Science (Chemical Technology)

2nd CET Diploma in Applied Science (Forensics)

Deli Delite Food Training Kiosk

2013

1st Agilent Partner Laboratory in the South Asia Pacific and Korea region

3rd CET Diploma in Applied Science (Aquaculture)

GI testing of 100 local foods towards development of 1st local Asian food GI database by GIRU

Specialist Diploma in Environment & Water Technology

Toxicology lab at TP by InvitroCue

2014

BOOST (Biologics Overseas Skills Training) programme (in conjunction with WDA, EDB)

Singapore's 1st low GI baked rice meals at Bistro Walk

Specialist Diploma in Biopharmaceutical Technology

Specialist Diploma in Laboratory Management & Instrumentation

Surge Research & Education (SuRE) Programme

2015

1st commemorative cookbook, *Singapore Hawker Classics Unveiled* (with support from SG50 and National Heritage Board)

Baking and Culinary Science team promoted Singapore hawker food in Paris at *Saveurs de Singapour sur les Berges de Seine*, part of the *Singapour en France – le festival* event

Inaugural Institution of Aquaculture Singapore (IAS) Conference co-organised by ASC and IAS

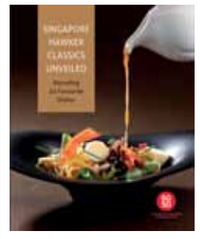
Inaugural TP-AVA training workshop on farm crisis management planning

Institutional Review Board

R&D floor space from 5,600 sq metres to 11,800 sq metres

Specialist Diploma in One Health (in collaboration with AVA, MOH and NEA)

Village Café Social Learning Enterprise at Glocal Connect Village



Message from Principal & CEO

Mr Boo Kheng Hua

In 2000, there was a push at the national level for science to be a key pillar of the Singapore economy. Life Sciences was earmarked as the fourth pillar of the manufacturing sector. Against that backdrop, the mission of the School of Applied Science (ASC) then was to train and prepare school leavers to meet the rapidly growing demand for life science professionals in the industry. This mission remains relevant today. ASC has grown from strength to strength since its establishment in 2000, and I am pleased to present its inaugural biennial report.

ASC has always been responsive to changes in the industry. Over the years, it has identified important trends and created opportunities for both staff and students. The recent announcement and swift implementation of the Government's *SkillsFuture* movement may have taken many by surprise, but the team at ASC welcomed the development with much excitement. The learning environment at ASC has been *SkillsFuture*-oriented since 2005 when it set up Koolwerkz Learning Enterprise, the first such enterprise at Temasek Polytechnic.

At Koolwerkz, students learn about ice cream processing, inventory management, hazard analysis and critical control point (HACCP), quality control and assurance, logistics and marketing functions as in real business scenarios. ASC also runs the TP Animal Clinic which provides training opportunities for Veterinary Technology students, and the Village Café Social Learning Enterprise, an F&B training ground that allows students to practise and experience productivity in a real business model.

Under *SkillsFuture*, the team at ASC has put in place an Enhanced Structured Internship Programme (ESIP) to better support students' career exploration and workplace learning. The duration of the enhanced internship will increase from 20 weeks to 26 weeks for most of ASC's courses. Students will be given opportunities to integrate classroom learning with real-world practical application to develop professional skills. Meaningful work assignments in the industry will deepen students' technical and soft skills, ultimately leading to better career choices. They will also gain valuable applied experience and opportunities to network in a professional setting. ASC students are also exposed to industry practices through the TP-linked enterprises such as the Agilent Partner Lab @TP, and the TP-Apollo Live Feed Research & Production Centre.

Industry engagement is at the heart of *SkillsFuture*, and I am happy to report that ASC has a good track record in this regard. In Glycemic Index (GI) testing, for example, we are leading the way, by being the first in the world to have SINGLAS accredited GI testing. The team at the Glycemic Index Research Unit (GIRU) has made significant developments in the research of *in vitro* and *in vivo* GI testing, and low GI product development and testing. Another example is our Analytical Science capability. In the last five years alone, ASC has provided consultancy services in analytical science to more than 50 companies, in a wide range of industries such as traditional medicine, food, aquaculture, renewable resources, pharmaceutical, as well as medical technology. ASC's researchers are also pioneering exciting translational research work in areas such as aquaculture, green materials, point-of-care diagnostics, and nutraceutical, pharmaceutical & biologics technology. In short, ASC's deep ties with industry, carefully nurtured over the years, will continue to benefit the industry, our staff and our students.

It is the passion for science and research that has enabled ASC to push ahead and break new ground in offering innovative solutions to industry as well as society. Infusing industry realities into its programmes and remaining true to its endeavour of bringing education to life and life to education, ASC leads the way in applied science education & training and will continue to produce graduates that are economy-relevant and future-ready.

8th School Advisory Committee

Back row (left to right)
Mr Mock Siew Fai, Mr Bernhard Schaufelberger, Dr Manjeet Singh, Ms Chang Kwei Fern, Mr Lucas Ng Hong Kiang, Assoc Prof Too Heng Phon

Front row (left to right)
Ms Low Min Yong, Mr Andrew Tjioe, Dr Lee Chee Wee, Assoc Prof Elizabeth Ng Siew Kuan

Not in photo:
Dr Allan Lim
Ms Ang Hui Gek
Dr Annie Ling Mei Chuan
Ms Lee Choon-Siew
Ms Lynn Chua Shu Xian
Dr Ng Lee Ching
Assoc Prof Paul Heng Wan Sia
Mr Teng Chong Seng
Dr Wong Hon Mun

INTERVIEW WITH CHAIRMAN

Leading Change in Applied Science Training

Mr Andrew Tjioe
Chairman / School Advisory Committee

Founder & Executive Chairman, Tung Lok Group
President of the Restaurant Association of Singapore (RAS)

1. How relevant and effective is ASC in addressing the needs of the applied science industry?

ASC trains school leavers in seven different areas – Applied Food Science and Nutrition, Baking and Culinary Science, Biomedical Science, Biotechnology, Chemical Engineering, Pharmaceutical Science, and Veterinary Technology. With their specialised knowledge and skills in applied science, our graduates work alongside other professionals in the hospitals, research institutes, and the food industry, as well as the veterinary, pharmaceutical and chemical engineering sectors, helping to improve lives and solve society's problems.

In the area of Continuing Education Training (CET), we strongly support the national imperative of helping Singaporeans to be lifelong learners, building deep skills that enable them to grow as specialists.

Therefore, in the Singaporean education journey, ASC plays a special role, working closely with industry to identify trends for manpower training purposes.

2. Today, the education landscape is undergoing a dramatic change, locally as well as worldwide. What is the biggest challenge facing ASC in these uncertain times?

The world is indeed becoming more complex and turbulent. Seismic changes are happening – technologies disrupting industries, big data exploding and overwhelming us, financial tsunamis creating havoc globally, the list goes on. In this landscape, educational institutions as a whole – not just ASC – are facing unprecedented challenges that require new responses and bold solutions. So, whilst we are effective and relevant *today*, we must be aware that our response to these changes makes the difference between survival or extinction.

So, the biggest challenge, as I see it, is *how* to adapt so as to be sustainable and relevant amidst the volatility, uncertainty, complexity and ambiguity. We must adapt or face the consequences.

3. So is the education industry under threat?

Many large educational institutions are behemoths that respond to change, if at all, at the sluggish speed of a sloth. Now, we all know about behemoths such as IBM and Eastman KODAK – seemingly indestructible in their heyday – that are now iconic examples of the failure to adapt. The education industry must move fast, because the changes coming our way are real, fast, and furious. Our competitors are no longer 'the usual suspects' that we know so well. Our new competitors will be 'unknown unknowns' coming from unexpected sources.

Take a closer look at the traditional education system. Most institutions of higher learning (IHLs) are historically over-centralised, highly integrated, and highly regulated, with great emphasis on standards and accreditation. Much of the teaching infrastructure is interdependent, making change extremely difficult if not impossible. IHLs also operate on the basis of 'standardisation' instead of 'customisation'. So, for example, the system does not take into account students' multiple learning styles, multiple intelligences, different pace of learning, or their home and family backgrounds.

This is a system that is not keeping up with the needs and demands of 21st century learners. We have to acknowledge that the current system is not sustainable, and that the only way to ride the changes successfully is to push for 'disruptive innovation' in education.

4. Moving forward, what advice do you have for ASC? How can ASC prepare itself for a future that is so uncertain?

Fortunately, uncertainty can be mitigated by vision. A clear vision will lead to clear results. And I am happy to report that ASC is already doing the right things in many ways. We have formed deep partnerships with organisations whose goals are aligned with ours. We have a good track record of serving and supporting industry. We must strengthen and intensify these efforts.

ASC must continue to make research and development (R&D) a key focus of our strategy. R&D is the only way to ensure our sustainability. By engaging in R&D, we develop specialists amongst staff, hence building our resources.

Next, we must continue to serve industry. R&D and service make a powerful combination. They ensure our staff remain relevant and up-to-date with industry developments. Students, in turn, have meaningful real-world assignments and contexts. There is constant 'sharpening of the saw' that results in a virtuous cycle of benefits, where both staff and students eventually attain mastery, perfected by experience and time.

Finally, restructure if necessary to remain agile.

We cannot underestimate the power and impact of what is happening around us today. If we continue along this track, we will always be nimble and ready to move fast. Our graduates will be similarly equipped with the skills and mindset to work confidently, however volatile the environment.

The next tsunami, in whatever form, may come, and we will be ready.

INTERVIEW WITH DIRECTOR

Reinventing ASC: Disrupting Education, Shaping the Future

Dr Lee Chee Wee
Director / School of Applied Science

1. What is the strategic focus of the School?

Singapore is striving to be amongst the world's most research intensive, innovative and entrepreneurial economies. With this in mind, we have anchored three cornerstones that support our core business of training, and are essential to our survival and success. They are: *Education, Research, Innovation and Enterprise (RIE),* and *Service*. This is an interconnected three-pronged approach that is aligned with the government's recent direction of moving the Singapore economy up the innovation ladder, from being 'value-adding' to 'value-creating'.

2. Please explain the rationale behind the strategic focus.

To be 'in the industry, for the industry' – that is our goal.

'Education' forms the core of our business. We have a system that ensures our students are well grounded in core subjects in the first year, followed by specialisation in the second year. In the final year, they have the option of choosing from 15 industry elective clusters. The flexibility in the final year gives students agility upon graduation.

At the same time, we build our capability through our RIE activities. Focusing on four R&D clusters, we are developing domain areas, competency areas as well as skillsets amongst staff to drive these activities. RIE ensures our sustainability, as highlighted by Chairman in his interview.

The third and final cornerstone, 'service', keeps us relevant, and gives our RIE activities purpose, context and meaning. We are committed to supporting small- and medium-sized enterprises (SMEs), especially in the area of innovation. We help SMEs to innovate and upgrade by tapping on our scientific capabilities. We've had many successful collaborations with SMEs, allowing them to adopt technologies to enhance or develop new products, processes, applications, best practices or operations.

3. How is ASC pushing for disruptive innovation, as advocated by Chairman, within its system?

ASC must reinvent itself to achieve sustainability and maximum efficiency. We are working towards developing a hybrid model that breaks the interdependent architecture of the traditional system. In this model, we envision a system where knowledge is easily accessible, where skills can be practised until mastery is attained, and where the experience and wisdom of our staff may be fully utilised by learners, thus enriching and creating value to students' learning. All these can be achieved because of the Education, RIE and Service strategy we have put in place.

Modularisation will be a critical component of the system. Students will be able to customise their education for their different needs from various components. More students can take more classes covering more topics, unbound by the constraints of time or space. We will introduce agility while maximising efficiency.

This model will also leverage on collaboration with external partners. Let me explain. With our rich R&D culture and cutting-edge facilities, ASC can augment our partners' on-line courses by providing the laboratory and clinical environment for applied science training. Joint certification is an exciting possibility.

What's more, ASC can offer sub-components such as mentoring by our experienced lecturers and researchers, making their expertise available to all students regardless of location.

4. What are the opportunities in higher education, specifically continuing education and training (CET)?

The issue of non-consumption in higher education is a serious one, not just in Singapore but all over the world. The massive pool of adult learners often cite cost, inconvenience, or commitment as reasons for not taking classes. They *can* be converted. And the upstarts know this – that adult learners want convenience, and the ability to mix and match content. So we see higher education unbundling right before our eyes. Content is rapidly becoming more modular or unbundled. The customers now have affordable products – courses and training programmes – that they can access from anywhere, even the beach.

This is the tantalising scenario for continuing education learners today: no more tiring night classes. Master new skills and make a career change in a matter of weeks. As long as you have an Internet connection, you can take courses from the world's top universities. You can engage in stimulating discussions with global classmates from Antwerp, Beijing, or Cyprus, guided by the world's most well-versed professors. For free.

MOOCs and other on-line courses are giving rise to a workforce that is passion-driven. This trend is fully acknowledged by the recent *SkillsFuture* initiative. We are already aligning ourselves with this direction to recognise employees' skills beyond academic qualifications. We will expand our line-up of CET courses which currently include programmes in One Health, Aquaculture, Forensics, Chemical Technology, Environment and Water Technology, and Laboratory Management and Instrumentation.

Continuing education powered by on-line learning can reverse the non-consumption trend.

5. Why does disruptive innovation matter to ASC?

Through disruption, high quality education now becomes accessible and affordable to all. Disruptive innovation in education also leads to personalised and customised learning, leading to greater personal, career and life success.

The late Mr Lee Kuan Yew said, "Survival requires you to change"… five simple, yet ominous words that we take to heart. Now, more than ever, we must re-imagine the status quo. With disruptive innovation, we can improve the system. We can shape the future of ASC.

ASC Management

Seated (left to right):
Dr Shabbir M Moochhala, Dr Lee Chee Wee, Mrs Tay-Chan Su Chin, Dr Ong Seng Poon

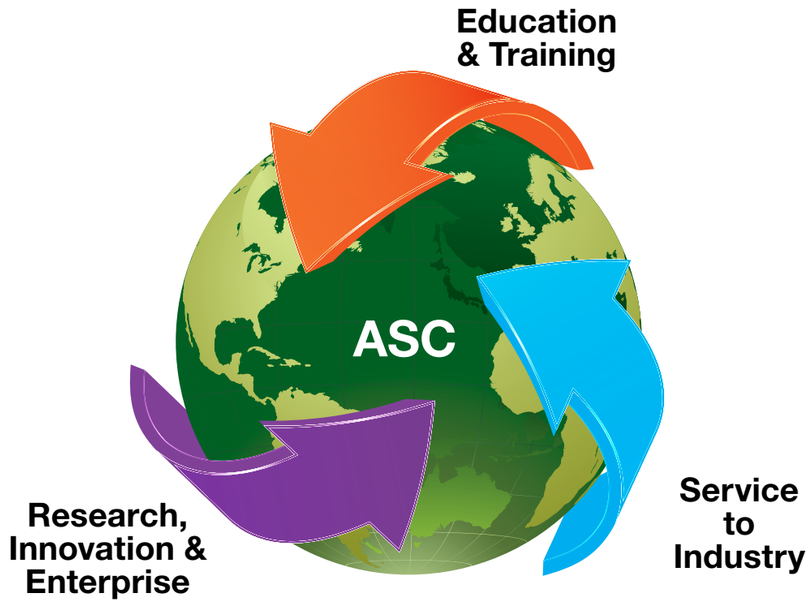
Standing (left to right):
Ms Tan Lay Khee, Dr Jiang Li, Ms Krishnasamy Susila, Mr Patrick Chan Lin Gim, Dr Patel Kadamb Haribhai, Mr Lim Teng Kuan, Dr Edmund Tian Feng, Dr Chooi Kum Fai, Dr Kho Choon Joo, Dr Quek Hung Hiang, Mr Wallace Lim Tse Loong, Mr Tay Boon Keat, Dr Padmanabhan Saravanan, Mr Loh Gin Hin, Mr Tan Keng Beng, Mr Tan Guan Hwa, Ms Petrina Lim, Dr Goh Lay Beng, Dr Diana Chan Pek Sian, Ms Hamida Zam Zam

Not in photo:
Ms Chew Swee Cheng
Ms Kalpana Bhaskaran
Dr Wong Sook Fun

Education Powered by Innovation

ASC has three cornerstones that support our core business of training, and are essential to our survival and success. They are: Education, Research, Innovation and Enterprise (RIE) and Service.

ASC's Strategic Focus



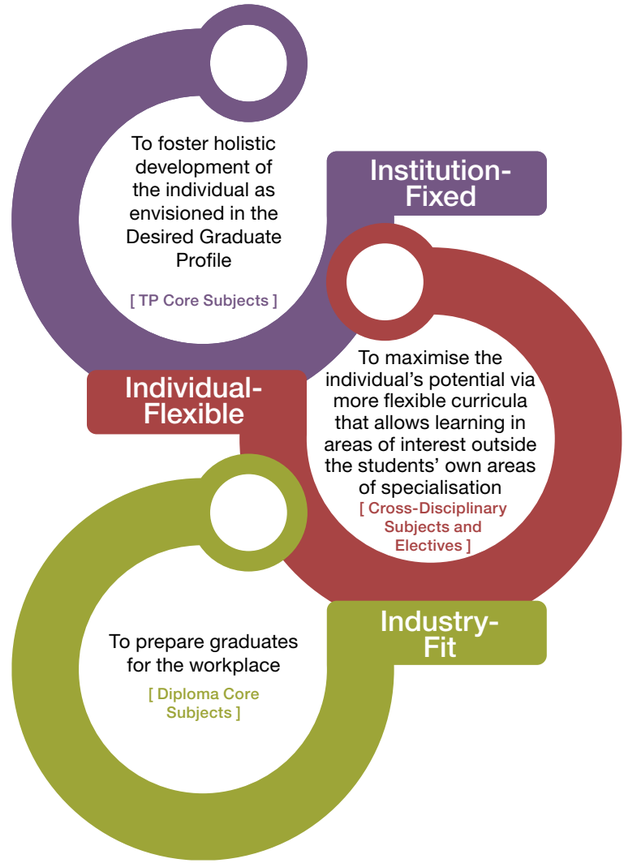
New technology sectors are poised to spur new innovation waves. Our focus on the three aspects of our strategy – Education, RIE and Service – has been carefully planned and aimed at catching the wave, seizing the potential and maximising the opportunities that come our way.

RIE powers our education process. With teams of researchers constantly looking for solutions to solve industry's problems, the entire education eco-system within the school is kept vibrant, relevant and up-to-date, ever ready to respond to the evolving needs of industry. The technology-driven trinity of Education, RIE and Service has resulted in an environment that is uniquely ASC, one where staff and students are immersed in the industry, for the industry.

3IFs @TP

ASC's curriculum is '**I**nstitution-**F**ixed' in that we foster holistic development of the individual through the fixed core subjects, '**I**ndustry-**F**it' because we prepare graduates for the workplace, and '**I**ndividual-**F**lexible', maximising the individual's potential via our flexible curricula.

Our diploma courses provide students the flexibility in their choice of subjects and pace of learning. It also offers learning opportunities to students beyond their own disciplines. All diploma courses are designed to deliver curricula that are Institution-Fixed, Industry-Fit and Individual-Flexible.



ASC's Academic Architecture

ASC's improved academic architecture was approved by the Senate on 8 January 2014. The first year focused on strengthening the foundation core through enhanced learning and teaching of subjects in Language & Communication, Mathematics & Statistics, Biology, and Chemistry. The second year focused on the core knowledge, concepts and skills of students' chosen diploma-specialisation. Finally, the third year shall emphasise work-based learning with an enhanced Student Internship Programme or Major Project, and the elective clusters offered on a year-long basis. With internship lengthened significantly to 26 weeks, students are further immersed in applied learning within the industry. This emphasis will prepare students better for future employment.

ASC Bridging Programme

The ASC Bridging Programme draws on social science research in the development of self efficacy. The design of the materials and the training of peer models are based on a framework that aims to help students believe in themselves and in turn, be willing to take up academic challenges. The peer models themselves learn to be humble and learn to serve others in the process. There is a marked improvement in the students' performance in all the subjects offered in the Bridging Programme.

Industry Elective Clusters & Internship Training

To further enhance Individual Flexibility, ASC offers 15 industry elective clusters across all ASC diploma courses. With the flexibility allowed in the selection of electives, students have wider exposure across applied science disciplines.

The industry elective clusters are:

1. Applied Chemistry
2. Aquaculture
3. BioEnterprise
4. Bioinformatics
5. Chemical Processing
6. Clinical Research
7. F&B Enterprise Cluster
8. Food Safety in Product Development
9. Forensics & Bioanalytics
10. Laboratory Medicine
11. Pharmaceuticals & Biologics
12. Pharmaceutical & Biologics Technology
13. Pharmacy Practice
14. Translational Biomedical Research
15. Veterinary

Participants learning about basic water treatment and water quality monitoring

Learning how to use a water quality monitoring test kit

Surge Research & Education (SuRE) Programme

Our three cornerstones are underpinned by the surge mindset, the ability to respond nimbly and effectively to challenges. This is reflected in the Surge Research & Education (SuRE) Programme initiated in 2014. Under this programme, road maps have been set up to build capabilities in rapid responses. Staff and students are also trained to respond swiftly to pathogen threats coming through veterinary sources. The aim is to have a ready and deployable team, to help in environmental surveillance, and be able to support diagnostics, identification and mitigation of a biological threat when an emergency arises. We are in the midst of strengthening our capability, and working with established local and overseas surge organisations to acquire protocols and methods.

With an innovative surge mindset and a culture of excellence, ASC leverages on its scientific capabilities to form the **ASC Biofactory**, a one-stop applied science centre for industry engagement.

ASC Biofactory

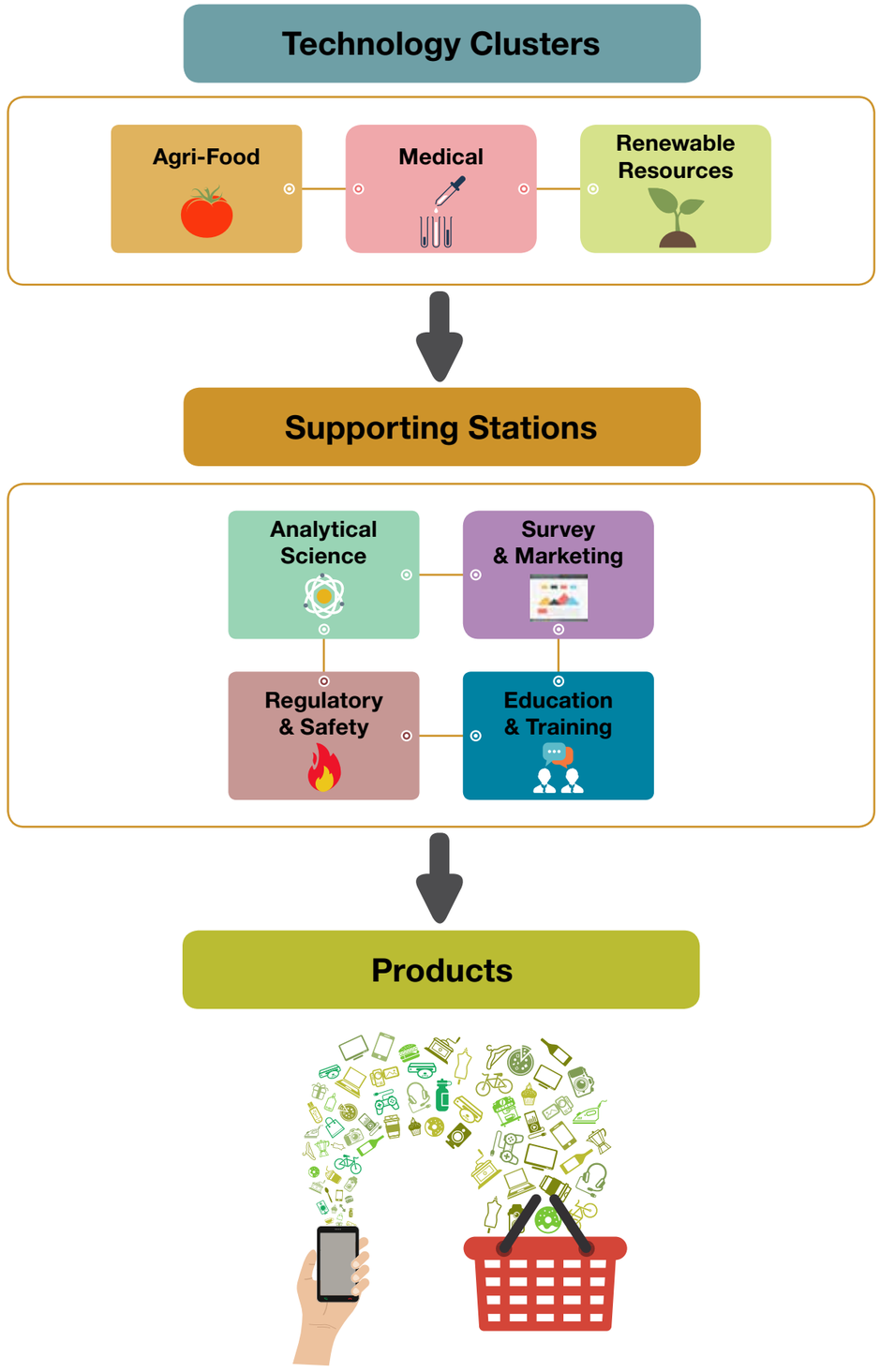
Providing Innovative Solutions For Enterprise

Our scientific capabilities are synergistically interlinked to form the ASC Biofactory, a one-stop applied science centre where project ideas are translated into products for commercialisation.

The Biofactory consists of various Biostations where each station will apply its expertise to transform the ideas, intermediate products and prototypes as they move along the value chain.

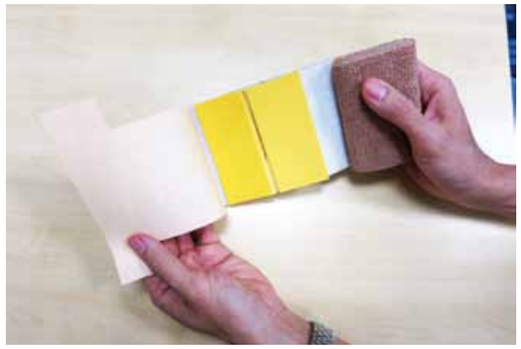
The Biostations are built upon ASC's existing three capability clusters, namely **Agri-Food Technology, Medical Technology** and **Renewable Resources Technology.** Each Biostation supports products and services in a way that is customised specifically to a company's needs, thereby giving the business a competitive edge. We are dedicated to helping companies achieve their business goals with innovative solutions and in a cost-effective manner.

By providing our expertise to match a need, leveraging on funding sources and industry partners, we take the project through to commercialisation, from concept to product.



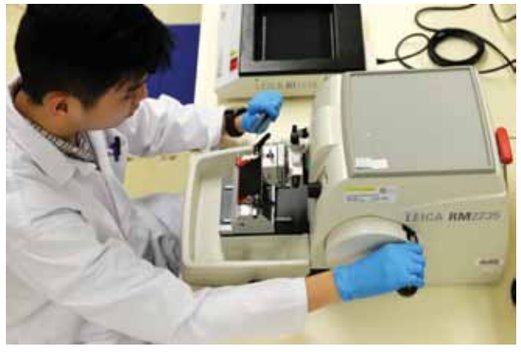
RIE Projects

With a history that spans fifteen years, ASC has gained the respect and recognition of industry for our wide range of expertise, high service standards, and commitment to providing innovative solutions to our stakeholders. We are driven by our desire to make a positive and sustainable impact. The industry projects and technology-related consultancy and services we provide see SMEs adopting technology to enhance or develop new products, processes, applications, operations or best practices.



3-in-1 Wound Dressing (Prototype)

Food safety testing using Liquid Chromatography-Mass Spectrometry



Cutting 4-5 µm sections of paraffin-embedded tissues using a microtome

Detection of porcine DNA in raw and cooked meat products

Agri-Food Technology Cluster

With multi-disciplinary teams of researchers supporting various industries spanning the hospital, fish farm, food production, F&B, traditional medicine, nutraceutical, healthcare, and sports & wellness, ASC is a one-stop centre for Agri-Food Technology solutions.

Aquaculture

Programmes

- Aquaculture Genetics, Breeding & Propagation
- Aquaculture Nutrition
- Aquaculture Health Management
- Sustainable & Integrated / High Density Aquaculture System

In the area of aquaculture, ASC strives to be a one-stop solution provider for aquaculture needs for both land-based and coastal sea farming through consultancy services, training and research. The four main focal areas of research and services are:

- **aquaculture nutrition**
- **health management including disease detection, treatment and prevention**
- **species growth, development and selective breeding**
- **intensive farming**

With increasing interest in land-based farming, our multidisciplinary research team also looks into developing cost-effective and eco-friendly ways of sustainable aquaculture especially in land-scarce Singapore.

Mud Crab Research

Satisfying the local hunger for Singapore's iconic dish, chilli crab, without depleting the resource is a challenge. This motivated ASC's researchers to look for ways to improve the survival rate of hatchlings and larvae of the mud crab (*Genus Scylla*), better known to Singaporeans as the 'chili crab'. The research targets to create a system that can be used by local aquaculture farmers, reducing the need to harvest the crabs from nature. Hatchery techniques developed from the current project, if developed further for commercial purposes, could provide aqua-culturists with a reliable supply of crablets (in Singapore and the region). Ultimately, the existing production as well as the conservation of the crab population in the wild will improve. The team will also work with conservationists to re-introduce juvenile mud crabs into natural habitats. In addition, the knowledge gained from the research can be adapted for other crab species.

Berried crab for mud crab project

Algae-Based Oral Vaccine for Fish

Vaccinating fish against disease traditionally involves methods that are stressful to the fish. Collaborating with TransAlgae Ltd (Israel), our researchers are developing a painless way to vaccinate fish. This first-of-its-kind algae-based oral vaccine for the fish iridoviral disease is Singapore's first fish oral vaccine for the local aquaculture industry.

This innovative oral vaccine product will be supplemented into the fish feed, thus allowing for easy non-invasive mass vaccination of fish fingerlings with no anaesthesia. There is also no handling stress to the fish, no flesh damage on the injection site, and no safety issues to the vaccinator. Algae biomass, an inexpensive material, is used to produce the vaccine, making it cost-effective and less susceptible to bacterial and fungal contamination. With unprecedented benefits that fish farmers will reap in fish health management, the innovative, affordable, user-friendly oral vaccine is expected to have a huge commercial impact.

Growing food in the laboratory for fish fry

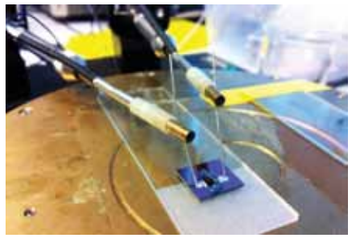
Development of On-Site Diagnostic Test for Stress Markers in Intensive Fish Farming

Most disease outbreaks in intensive fish farming are linked to stress, and currently there are no on-site tools to monitor stress in fish. Hence, we make fish healthcare our primary objective for sustainable aquaculture. Harnessing our in-house capability to immobilise enzyme and biochemical reagents on structurally modified paper, our researchers have developed a low-cost on-site diagnostic testing device that uses liver enzymes as early stress markers in farmed fish. This device requires only a small volume of test sample (serum or blood) and no external supporting equipment or power because fluid movement in the device is controlled largely by capillary action. Semi-quantitative results are obtained within five minutes. This quick and reliable on-site diagnostics test device can be used as a stress management tool by aquaculture companies, helping them to increase productivity by reducing cost and managing their resources better. Making tools that are affordable, reliable and user-friendly for aquaculture farmers has always been our objective.

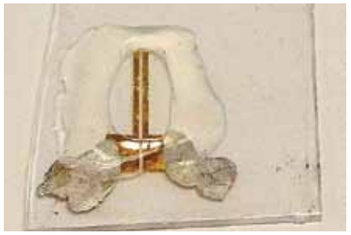
Biopen: Lab in a Pen – Low-Cost On-Site Novel Biosensor for Early Detection of *Vibrio Parahaemolyticus*

The lack of on-site rapid diagnostic tools for early detection of early mortality syndrome (EMS) in shrimp will soon be resolved with the invention of the *BioPen: Lab in a Pen*. This is a novel fully automated low-cost on-site biosensor for the early detection of the *Vibrio parahaemolyticus* virus in shrimp. With no trained personnel or access to a laboratory required, BioPen will be designed to prevent cross contamination of samples, providing safety to both the user and the environment.

The concept of BioPen is that the shrimp sample (DNA) will be captured by the tip of a fibre-optic which has been modified with DNA-specific probes. This novel device is expected to simplify and reduce the cost of detection and real time monitoring of *Vibrio parahaemolyticus* in shrimp farms. Farmers can use the BioPen as a management tool for their routine biosecurity process, enabling them to immediately take the necessary steps to prevent the spread of the virus and reduce their economic loss. This mobile diagnostic 'lab in your pocket' is set to make an impact on the aquaculture industry.



Detecting the change in electrical signal in the Carbon Nanotube Field Effect Transistor



Carbon Nanotube Field Effect Transistor (Crucial part of the developed gas sensor)

Novel technologies for inducing insect pest resistance in vegetables

Plant Biotechnology

Programmes

- Plant Cell Technology & Propagation
- Intensive Urban Farming Systems
- Plant Health & Pest Management

The plant biotechnology team works closely with industry partners in providing scientific consultancy, training, research and testing services. Areas include plant tissue culture & propagation, plant health & pest management, and urban integrated intensive farming technologies like vertical farming, hydroponics and aquaponics. With the increasing need for maximising land utilisation for optimum productivity returns, our multidisciplinary R&D team also looks into non-GMO ways of enhancing plant productivity, and developing sustainable and cost-effective urban farming systems.

Novel Technologies for Inducing Insect Pest Resistance in Green Leafy Vegetables

Concern over the use of chemicals in pest management has prompted us to develop pest resistance in crops using LED lighting technology. The researchers will evaluate the impact of LED lights on the productivity of leafy vegetables, the effects on the growth and development and also nutritional content of the leafy vegetables. The team is analysing the differentially expressed microRNAs involved in abiotic and biotic stresses in leafy vegetables. Specific microRNAs would then be used for further enhancement of leafy vegetables. The specific leafy vegetables showing significant enhancement in productivity, nutritional value and high resistance to insect pest infestations will be selected for breeding purposes or developing further resistant varieties. This approach will give an opportunity to vegetable growers in Singapore and the region to use a sustainable, cost-effective, eco-friendly and non-chemical way to control insect pest infestations, thereby boosting productivity of the ecosystem besides many other ecological and environmental benefits. Our researchers are making a difference in reducing environmental pollution and increasing the overall productivity of leafy vegetables in Singapore.

Low GI baked rice meal

GI testing of local foods

Food and Applied Nutrition

Programmes
- Food & Culinary Applications
- Applied Nutrition Research

Through science-based nutrition research, healthier food innovation, delivery of public education and customised training programmes, we create value and enable businesses to develop capabilities, boost productivity and improve health for the masses.

The Glycemic Index Research Unit (GIRU) at ASC, run by our researchers, is the first SAC-SINGLAS accredited facility in Asia to conduct Glycemic Index (GI) testing and research and offer consultancy services. GIRU has tested over 200 foods for their GI values. In addition to GI testing, GIRU also offers glycemic response testing and insulinemic index testing, and conducts customised workshops and talks to educate consumers in the area of GI.

Serving Singapore's First Low Glycemic Index Meals on Campus

We develop meals with your health in mind. Thus, the mounting media attention on the health benefits of eating low GI foods sparked off a good opportunity for ASC to innovate and launch its own low GI meals on campus. Our food technologists developed a range of low GI baked rice and pasta meals for the course-managed café. The launch of the low GI meals makes the café the first F&B outlet in Singapore to serve complete low GI meals. Creating healthful meals of the future is our business.

Glycemic Index Testing and Research – Blazing a Trail in Carbohydrate Research

GI research at ASC stems from our firm belief that GI can be used as a tool for health promotion. The research team at the Glycemic Index Research Unit has made significant developments in the research area of *in vitro* GI testing, *in vivo* GI testing, and low GI product development. In addition to offering highly consistent and reproducible GI analyses in our accredited laboratory, the development of functional food products at ASC has expanded beyond single food products to full-fledged meals that are classified as low GI. This scaling up of functional food research has also led to the development of various low GI products.

With funding from the Health Promotion Board (HPB), GIRU has spearheaded the GI testing of local foods towards the collation of a local GI database. This trail-blazing project is a first in Asia and perhaps in the world. This database will benefit people of all ages, gender, ethnicity and health status. A low GI meal plan is beneficial in many ways, such as facilitating weight loss, lowering blood cholesterol level, preventing and managing diabetes, and reducing the risk of heart disease, to name a few. Knowing the GI of food and how to apply it in optimising a healthy diet has many health benefits, as with this knowledge, consumers are able to optimise their diets and lifestyles.

Medical Technology Cluster

The diagnostic wing of ASC is helmed by a team of established research scientists focusing mainly on the development of point-of-care testing platforms and *in vitro* diagnostics for application in aquaculture, medical technology, food and environment-related industries. Currently, ASC is developing biosensors for non-invasive diagnosis of infectious diseases and pathogens. This is of significance in aquaculture and the food industry, for disease surveillance as well as ensuring food safety and food security.

Point-of-Care (POC) Diagnostics

Programmes
- Genetic & Non-Antibody-Based Systems
- Label-Free Diagnostic Assay
- Low-Cost Diagnostics & Biosensors

Low-cost, user-friendly, fieldable in vitro diagnostic (IVD) test platforms are being developed at ASC. The team taps into the latest technology in molecular diagnostics to provide customised solutions and services for biological and biomedical applications. Solutions can be created for the aquaculture, agriculture, food, veterinary, environmental, biotechnology, and home care industries.

Innovative On-Site Detection of Food Contaminants: Optical Immunoassay (OIA) Food Toxin Kit

Rapid on-site diagnosis of food contamination is of priority to safeguard public health. Current methods to detect food contaminants are lab-based and require a turnaround time of several days. In collaboration with DSO National Laboratories and with support from the Environmental Health Institute (EHI) of the National Environment Agency (NEA), we have developed a novel method that can concentrate and detect biological contaminants in food within two hours instead of two days, without the need for expensive laboratory equipment. The innovative detection kit uses silicon wafer chips. To date, it can detect three potential biotoxins: *Botulinum neurotoxin A, Staphylococcal enterotoxin B,* and *Clostridium perfringens epsilon toxin*. The kit includes optimised, user-friendly food processing protocol and tools for on-site testing of samples. The results can be read visually on site within two hours. The test is rapid, sensitive and can be used on site in food establishments such as restaurants and hawker centres. The kit is expected to enhance foodborne illness-related research and investigation, by shortening the screening process of pathogens in food and providing faster results, for timely risk mitigation. We aim to bridge the gap in the development of fieldable diagnostics that can be tailor-made and are customer-centric.

Virus titre (TCID50) determination in cell culture

Development of Low-Cost Microfluidic Diagnostic Platform

Disease monitoring and surveillance in developing countries can be dramatically improved if diagnostic tests are cheap, and can be performed anytime, anywhere, by anybody. Motivated by this goal, ASC's researchers have developed an innovative point-of-care (POC) diagnostic method for the diagnosis and monitoring of patients, animals, fish or shrimp suffering from disease. The project team has successfully optimised two different low-cost paper-based platforms (enzyme-based platform and paper-based ELISA). This simple POC method has the potential to improve the healthcare system in developing countries by reducing the number of clinical visits, decreasing costs to the patient, as well as improving clinical outcomes. The low-cost paper-based ELISA devices can also be easily adapted for use in other sectors, such as the food industry, aquaculture diagnostics, veterinary sector, home care industry, and in education kits.

On-Site Multiplex Device for Early Prediction of Kidney Damage

Kidney injury diagnostic tests are lab-based and currently there are no on-site or home testing kits available for diabetic patients to monitor their kidneys reliably. Our researchers have developed an affordable, sensitive, and simple point-of-care paper-based multiplex device for early prediction of kidney damage. As the device does not require a laboratory or skilled personnel, it will simplify and reduce the cost of detection and monitoring the progression of kidney disorders, and help to detect kidney damage early. Clinicians can have instant results within their premises and can make informed decisions to tailor the drug therapy required. It also helps patients to save valuable time and money, and can be used as home testing for kidney abnormalities. As Singapore has the fourth highest incidence of kidney failure in the world, this device is expected to have a major impact on healthcare management.

Washing of Optical Immunoassay (OIA) strip

Low-Cost On-Site Device for Rapid Evaluation and Awareness of Gout

Currently, the only way to check and monitor gout is through a blood test. There are no home testing kits available in the market which can help gout patients monitor their gout condition with ease. Hence, researchers at ASC are developing a low-cost paper-based microfluidic testing device for the detection of gout from various biological samples, that is, saliva, blood and urine. The device is enzyme-based. It is user-friendly and does not require skilled personnel or any equipment, and hence can be easily adopted for clinical or home testing. These cost-effective diagnostic devices can be used anytime, anywhere. The availability of a point-of-care test kit for uric acid will facilitate physicians' decision-making in managing acute gouty arthritis for their patients. Gout patients can take control by regular monitoring in the comfort of their home.

Nanohole Array Biochip-Based Point-of-Care (POC) System for Procalcitonin Measurement

Procalcitonin (PCT) is an early and highly specific biomarker in response to severe systemic bacterial infections and sepsis. The proposed point-of-care system is based on a nanohole array biochip which is developed by the Institute of Materials Research and Engineering (IMRE). This nanohole array biochip shows excellent biological sensitivity, and only requires a detection system configuration, making it an ideal platform for POC system development. With the integration of nanotechnology and MEMS technology, this POC system will be a revolutionary product for early diagnosis of bacterial infections and sepsis.

Particle Filtration Efficiency of Endonasal Device

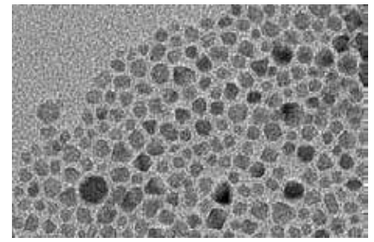
There is increasing demand for novel devices to prevent respiratory allergies. Our researchers conducted a study to evaluate the claims of an endonasal filtration device. Particle filtration efficiency was evaluated, alongside aerosol testing with a simulation of unhealthy to hazardous PSI (200-300) range, using varying sizes of silicon dioxide particles representing the PM10 and PM2.5 range. The device was found to prevent air pollutants (pollen, dust mites, PM10, PM2.5) gaining access to nasal cavities. This project has helped to enhance our capability to evaluate the performance of particle filtration and antimicrobial efficiency of masks and devices.

Antibacterial Efficacy of Semiconducting Photocatalytic Films

The alarming rise in drug resistant bacteria has resulted in the need for newer antimicrobial materials. ASC has an on-going collaborative research agreement with Photocatalysis Industry Association of Japan (PIAJ), to participate in the round robin test (RRT) and conduct *in vitro* testing on the photocatalytic materials (titanium dioxide blended films) for its antibacterial and antiviral activities, and perform on-site demonstration testing of films. ASC has successfully completed the RRT that was conducted among 17 different institutions representing eight different countries including Singapore. We are now better equipped to assess the antimicrobial efficiency of novel nanomaterials.

Cooling of paraffin-embedded tissues at 0°C

Paraffin sections on glass slides which can be kept indefinitely prior to staining



Magnetic nanoparticles synthesised for enzyme immobilisation

Preclinical Research

Programmes

- Animal Models
- Nonclinical Safety Studies
- Customised Studies for Vaccine Efficacy

The team taps into the latest technologies to provide customised solutions and services for preclinical research. This is supported by a new barrier facility which will house specific pathogen-free laboratory animals and swine. Solutions can be created for the biomedical and veterinary industries.

Determining Early Onset of Parkinson's Disease

A project focusing on Parkinson's Disease is currently in progress with the long-term aim of developing an animal model for neurodegenerative disease research. Our researchers are looking at ways to determine the onset of the disease, as well as early diagnosis that may lead to early treatment. The team is carrying out a preclinical trial to profile a panel of miRNA genes associated with neurodegeneration and Parkinson's Disease. By obtaining results from the preclinical trial, the long-term objective is to carry out similar miRNA profiling in human clinical samples. A panel of 13 genes have been identified and extracted from the mice to test for their potential to serve as biomarkers for Parkinson's Disease.

In Vivo and *In Vitro* Models to Evaluate Potential Antifibrotic Agents of Liver Fibrosis

The prevention of liver fibrosis is the focus of this project that uses a rat model and a hepatic stellate cell line to evaluate potential antifibrotic agents. Preliminary studies using the cell culture system allow rapid assessment of the efficacy of the agent, prior to further testing using the animal model. This rat model closely mimics human liver disease from initiation to end-stage fibrosis in the short span of five weeks. The team evaluates the effect of the antifibrotic agent on gene expression using quantitative PCR, changes in liver enzymes using serum biochemical assays and the severity of liver fibrosis using histopathology, histochemistry and pathological scoring. The combined *in vivo* and *in vitro* approach has been used to evaluate different classes of potential prophylactic and therapeutic antifibrotic agents, and identify their mechanisms of action in the prevention of liver fibrosis.

Evaluation of the Immunogenicity of a Porcine DNA Vaccine

The ability of a novel DNA vaccine to elicit an immune response was tested using rodents. This vaccine was originally developed by a private company for a respiratory disease in swine. The client was interested to know if it was capable of eliciting an immune response. Our team of researchers recommended that the testing of the immunogenicity be performed in a rodent model as proof of concept before proceeding to tests using swine. Through innovative approaches in measuring the immune response using a modified ELISA assay, and by applying a customised programme in the analysis of the results, it was determined that the DNA vaccine was immunogenic in the rat. The company has approached ASC to conduct further tests on this vaccine. The proposed project aims to assess various ways to improve the immunogenicity of the vaccine.

Nutraceutical, Pharmaceutical & Biologics Technology

Programmes

- Nutraceutical / Pharmaceutical Formulation
- Nutraceutical / Pharmaceutical Manufacturing
- Biologics Manufacturing

The Nutraceutical, Pharmaceutical & Biologics team helps companies to develop new formulations and health products. We offer a suite of services from product development to safety, efficacy and stability testing. We also provide support and training in Quality Assurance matters especially in current Good Manufacturing Practices (cGMP).

3-in-1 Wound Dressing

The 3-in-1 wound dressing project created an excellent platform for ASC to work across various disciplines, from formulation to preclinical and clinical testing, and finally to product registration. Boasting three different functions, the 3-in-1 Wound Dressing is a novel, first-of-its-kind bandage – it is the only dressing that has an antibacterial capability, encourages bleeding to stop quickly, and can be applied easily using just one hand. The project was financed by the Ministry of Defence (MINDEF) through the Defence Science and Technology Agency (DSTA). The team has successfully formulated an active film to exhibit both antimicrobial and haemostatic properties and is currently undergoing pilot scale production and preclinical trials. The 3-in-1 Wound Dressing will be a boon for injured soldiers awaiting medical attention. It also has a huge potential for use in other healthcare settings such as in emergencies.

Tablet Coating Formulation and Method Development

Solving formulation and quality assurance issues for the industry is an important aspect of our service. This area of work allows staff to put their expertise into action and also creates a rich environment for students to learn and train in. This project was undertaken with that objective in mind. We are developing improved tablet coatings for a client's nutraceutical product, and the project includes formulation development and stability studies. It also encompasses the development and validation of assay tests for multi-component products. Led by a team of lecturers, final year students have the opportunity to apply what they have learnt in Pharmaceutical Manufacturing Technology, Pharmaceutical Analysis and Current Good Manufacturing Practice to a real industry developmental project.

Haemostatic and Antibacterial Cream

ASC's Formulation Team constantly strives for product differentiation. In a spin-off from an existing medical device project, we have successfully developed an antibacterial cream that delivers 2-in-1 benefits in the form of a stable aqueous base cream that has a good texture. Analytical tests have shown that the cream reacts with blood to form a gel-like material and thus aids in blood clotting. The cream has better antibacterial properties than an over-the-counter antibiotic cream. Currently, we are starting preclinical efficacy and biocompatibility tests. Treating cuts and wounds will be quick, easy and fuss-free with this cream and its ability to stop bleeding rapidly.

Pharmaceutical Manufacturing Facility

ASC houses a Pharmaceutical Manufacturing Facility which is designed to meet current Good Manufacturing Practices (cGMP). It has a class 100k drug formulation and preparation room, and class 10k aseptic dispensing room. It allows students to experience secondary pharmaceutical manufacturing of various dosage forms such as capsules, syrups, tablets and creams, as well as aseptic drug dispensing commonly used in the preparation of parenteral nutrition and therapeutic drugs. The facility is equipped with the necessary utilities and documentation according to regulatory requirements simulating a cGMP-certified manufacturing facility. This facility is used for both student training and also for dosage formulation work with companies. Stability chambers and a suite of pharmaceutical analytical equipment are available for performing various characterisation and stability testing.

Biologics Manufacturing Skills Training Programmes for Industry

ASC is a proud partner of Workforce Development Agency (WDA) in several CET programmes aimed at training highly skilled manpower for the fast-growing biologics manufacturing industry. Working with industry giants like Lonza Biologics, Novartis, Roche, and GSK Biologicals, ASC has progressively launched the Biologics Overseas Skills Training (BOOST) Programme, Local Biologics Skills Training (LBST) Programme, and Biologics Manufacturing Professional Conversion Programme (PCP). This is made possible by ASC's expertise in pharmaceutical regulatory framework and biologics unit operations.

Renewable Resources Technology Cluster

The Renewable Resources Technology capability at ASC is broadly divided into three areas: Green Materials, Water Technology and Biofuels. Through industry and joint research projects, we aim to help companies reduce the cost of disposal or treatment of their solid waste or wastewater. At the same time, a valuable and usable product may be created in the process. This is particularly important in Singapore where resources are scarce and cost of disposal is extremely high.

Biofuels

Programmes
- Biobutanol
- Hydrothermal Technology

Biofuels – fuels produced from biomass – are a form of renewable energy and their use has a near zero carbon footprint. One major concern, however, is in the use of food crops for biofuel production. Moreover, bioethanol, being the world's largest commonly used biofuel now, cannot be used in its totality in petrol engines and has to be blended with petrol. To alleviate these issues, the team of researchers at ASC is currently investigating the development of biofuels from non-food feedstock, including lignocellulosic materials, through two strategic programmes, namely biobutanol and hydrothermal technologies.

Biomass Pretreatment Process and *Clostridium* Strain Development

Biobutanol is a much better biofuel than bioethanol because its energy density is higher and it can be used in its totality in petrol engines. However, the relatively low fermentative yield and the need to use non-food crops as feedstock are two main obstacles that must be overcome for commercialisation to take place.

Non-food feedstock, especially lignocellulosic materials, need to be pretreated to convert the complex carbohydrates into fermentable sugars before fermentative biofuel production can take place. We are developing pretreatment strategies, including the use of thermal methods, to utilise such biomass, including waste wood and sugarcane bagasse. The developed technology will lead to higher yields from the subsequent fermentative biofuel production, hence, paving the way for commercialisation of biofuel production from non-food crops.

Through mutagenesis, we have developed a *Clostridium* strain that has improved biobutanol yield when it is cultivated in media prepared from waste feedstock, e.g. waste wood and sugarcane bagasse. The use of metabolic engineering techniques also allow the modified strains to better utilise some of the sugars that are difficult to be fermented, like pentoses. This technology will benefit food security, energy supply and environmental wellness.

Hydrothermal Liquefaction of Organic Wastes

Current methods of waste processing include incineration and digestion. Energy recovery is low for incineration while digestion is slow and complex. Researchers at ASC are aiming to develop the process flow for the conversion of the waste streams (e.g. food waste) to biofuel via hydrothermal liquefaction (HTL). HTL is a simpler process which is environmentally friendly and with high energy efficiency. It also eliminates the pre-processing of wet waste via drying. The results from the operational and optimisation studies will build up the know-how in the implementation of this technology and can be used to demonstrate the technical and economic feasibility of the process.

Engineered Cementitious Composite (ECC)

Rebound hammer test on ECC

Developing new cultures for microbial fermentation

Green Materials & Nanotechnology

Programmes

- Green Materials
- Nanotechnology

In ASC, we focus on green materials development to promote recycling of solid wastes generated in Singapore. We have developed mix formulations that allow the recycling of wood waste, incineration ash and plastics into building materials for walls, park benches and even souvenirs. Our researchers are also working on the use of recycled plastics in hot mix asphalt, and plans are in the pipeline to set up an accredited laboratory to conduct material testing for green materials.

Our researchers are also making use of nanotechnology to create materials with unique functionalities. Nanomaterials of interest include nanomagnets, carbon nanotubes and heterogeneous nanocatalysts.

Engineered Cementitious Composite (ECC)

Turning wood and horticultural wastes into innovative and value-added building products, the Green Materials team at ASC collaborated with Sembcorp EOSM to develop the ECC-Crete sandwich panel in-fill wall system. The innovative ECC mix uses wood and horticultural wastes in cementitious building products for non-structural and structural applications. It has many advantages over the conventional wall system such as faster construction, enhanced quality control, labour-saving benefits and better flexibility to meet changing needs. The ECC-Crete system is used in prefabricated building assemblies locally as well as in India, Vietnam and Cambodia.

Recycling of Wood and Horticultural Wastes as Building Materials

Our continuous search for eco-friendly solutions forms the basis of a study on the use of wood and horticultural wastes as building materials. The results could potentially lead to diversion of close to 200,000 tonnes of wood and horticultural wastes into the building industry each year, which would otherwise have to be disposed of through incineration. We have successfully developed techniques capable of processing and pre-treating these wastes into suitable and consistent forms, and developed mix formulations to incorporate the wastes into cementitious composites. Currently, the team is exploring working with the relevant government agency to install park benches at our parks using these green materials.

Utilisation of Waste Plastics in Hot Mix Asphalt for Infrastructural Application

Currently, no integrated systems have been set up to convert as-received waste mixed plastics that are usually contaminated and non-homogeneous in nature into suitable, consistent and high value-added final products for infrastructural applications, especially in tropical climates and under heavy traffic conditions as experienced in Singapore. This project is carried out with a view to develop a technology to process waste plastics into suitable and consistent feedstocks (raw materials) for infrastructural applications. The project covers both experimental and analytical work to evaluate the use of waste plastics in hot mix asphalt and bituminous waterproofing materials for infrastructural applications (e.g. road and underground construction, carpark, waterproofing resins and roofing sealants). The study aims to provide an innovative and unique solution from the engineering, economical and environmental perspectives for the management and recycling of waste plastics in Singapore, which have been increasing rapidly due to urbanisation and industrialisation.

Use of Recycled Plastics in High-Performance Composites and Nanocomposites

This is a study on the use of recycled plastics in high-performance composites for infrastructure and buildings, as well as nanocomposites for protective structures. The objectives are to explore the incorporation of sorted and mixed recycled plastics in high-performance composites and nanocomposites that adopt local materials and construction technology, and to produce these composites to suit the harsh climatic and service conditions in Singapore and the tropical region. The focus is on scientific and engineering applications that are technically beneficial, economically viable and non-hazardous to the environment, which include the use of sorted and mixed recycled plastics in infrastructure, buildings and protective structures.

Magnetic Cellulases for Recycling of Enzymes for Fermentative Biofuel Production

Cellulase is used in the breaking down of cellulosic waste materials into the starting materials used to produce biofuels. However, the cellulose is often lost during the process. We have successfully identified the most suitable crosslinker to immobilise cellulase on the nanoparticles. We have shown that cellulase can be recovered and reused effectively for more repeated cycles. Such enzymatic immobilisation onto magnetic particles can be used to attach various biomarkers onto magnetic nanoparticles to be used as early detection kits for various diseases.

Multiplexed Detection of Biogenic Volatile Organic Compounds (Bvoc) Using Carbon Nanotube Field Effect Transistors

An advanced sensor technology is being developed for the detection and continuous monitoring of gas emission by plants under stress. A single walled carbon nanotube field effect transistor (SWCNT FET) device can achieve the required sensitive and selective detection of the target gases. Receptors have been immobilised and tested for selectivities of volatile compounds such as acetone, methanol and ethanol. Such a sensor platform technology can be used not only to monitor plant stress but also for other applications such as detecting biomarkers for diabetes.

Water Technology

Programmes

- Recirculating Aquaculture System (RAS)
- Wastewater Treatment

To assist the aquaculture industry in Singapore, our focus has been on the development and better understanding of the RAS. Our successful completion of kinetics studies of fluidised bed bioreactors (FBR), a widely used system within the industry, is facilitating scale-up design. As traditional bioreactors result in the conversion of ammonia in fishwater into toxic nitrates, we are investigating the feasibility of incorporating algae, or the use of phototropic reactors, for the removal of nitrates from water so as to achieve almost 100% recycling of the wastewater.

Also being developed is a technology that allows for natural selection of microbes that produces bioplastics during the municipal or industrial wastewater treatment process. This innovative process allows for the treatment of wastewater, and production of bioplastics to occur simultaneously.

Characterisation of water parameters by spectrophotometry

Bioremediation of fish tank water by microalgae

Development of Innovative Phototrophic Biofilm Reactor Used in Recirculating Aquaculture System (RAS) for Intense Freshwater Fish Farming

A technical solution that improves water quality in RAS's while reducing costs would lead to two distinct economic advantages for fish farmers. The accumulation of nitrate in the conventional RAS poses a problem to the water quality, and is detrimental to the ecosystem. To mitigate these adverse effects, currently most RAS's operate with up to 20% water exchange every day, which increases the water consumption and overall operating cost. A new nitrogen-controlling technology in RAS being developed by our researchers could potentially be used for intensive freshwater fish farming, when land and water resources are limited. The phototrophic biofilm reactor (PBR) technology to be developed in this project will achieve both nitrification and denitrification to remove nitrogen from RAS. Moreover, the phototrophic biofilms used in PBR are naturally available, easily cultivated and can potentially be used as fish feed. With the PBR system, SMEs and fish farmers will achieve 100% water recycling or zero water exchange without paying high water bills or investing in additional treatment processes.

An Algae-Based Circulatory System for Treatment of Wastewater from Fish Farming

The innovative use of microalgae by our researchers is paving the way for more sustainable practices in aquaculture in Singapore. A complete aquaculture waste treatment system currently in development is harnessing the power of microalgae to reduce the inorganic and organic load of food fish wastewater. The treated water is circulated back into the aquaculture system, while the accumulated algae are harvested for use as agricultural fertilisers. Two suitable microalgae species are being used in the pilot studies using fish water from the rearing of sea bass. The system can potentially reduce the water and energy consumption in aquaculture significantly.

Development of an Intelligible Solution for Sustainable Fish Feed Supply

Fishmeal is used as one of the most popular protein sources in the diet for fish culture. However, its increasing market prices and competition with human consumption for food fish are affecting the profitability of aquaculture. Converting algae biomass from the treatment of fish water into algae-based fish feeds is an innovative solution being investigated by our researchers. Different types of algae species will be combined to give a desirable nutritional value of the feeds. This innovation has enabled us to derive high-value fish feed from low-cost microalgae obtained from the treatment of aquaculture waste. This can enhance the self-sustainability of aquaculture systems with substantial savings in the cost of fish feed.

Bioplastics Mixed Culture Development from Waste Oil and Grease

Conventional plastics are made from fossil fuels. However, the rate of plastic production and consumption far exceeds the rate of fossil fuel formation. Polyhydroxyalkanoates (PHA), a new type of 'bioplastic', are a group of polyesters produced by microbial cultures. This exciting and innovative project aims to develop a mixed culture technology that will enable the growth of PHA-producing microorganisms by natural selection. It will convert waste streams (i.e. waste oil and grease) to a valuable product, bioplastic. In addition, the treatment of waste oil and grease will also minimise the negative impact of current waste disposal methods.

Bioplastics Mixed Culture Development by Co-Treatment of Chicken Droppings and Domestic Wastewater

Co-treating chicken dropping and domestic wastewater to produce Polyhydroxyalkanoates (PHA) has the potential to ensure the sustainability of plastics and to create a greener and better environment for the entire world. PHAs are fully biodegradable and biocompatible. The innovative mixed culture technology will decrease the cost of PHA production and has immense potential for the plastic industry. In addition, the increased availability of bioplastics will have a positive effect on the environment, as the co-treatment of chicken droppings and domestic wastewater will also minimise the negative environmental impact.

Analytical Science Capabilities

Analytical Science is a central and multidisciplinary science, the heartbeat of any R&D or production process. ASC focuses on advancing its analytical capability in areas such as Chemical, Biological, Functional and *In Silico* Testing. To date, many analytical science projects have been carried out by ASC for industry partners, with the goal of ascertaining product quality, safety and efficacy.

Since 2009, TP has also obtained SAC-SINGLAS accreditations for food safety testing, alcohol testing, and porcine DNA testing. By continually developing and increasing the scope of our analytical capability, ASC is committed to helping enterprises innovate to remain competitive and tap into new markets.

BIOLOGICAL TESTING

Competencies

- *In Vitro* Bioassays/Assays
- *In Vitro* Manipulation & Validation
- OMICS Technology

CHEMICAL TESTING

Competencies

- Quantitative Analysis of CAM / Food Ingredients
- Analytical Method Development, Optimisation & Validation
- Metabolomics

FUNCTIONAL TESTING

Competencies

- Preclinical - *In Vivo* Testing
- Clinical Testing

IN SILICO TESTING

Competencies

- Biostatistics
- Bioinformatics
- Biomodelling

High Performance Liquid Chromatography (HPLC): A Leap Forward for the Traditional Medicine Sector

With an integrated approach in Traditional Medicine analytical capabilities, this is a one-stop centre offering a wide range of services from consultancy to training and research activities. Chemical and microbiological testing services are provided to ensure products are of high quality and safe for consumption.

Consistent quality is the basic requirement for complementary medicine. Using High Performance Liquid Chromatography (HPLC), ASC has been supporting SMEs by fingerprinting some of their products to ensure quality control. HPLC provides a comprehensive and up-to-date account of HPLC fingerprints of more than 40 traditional Chinese medicine and details their sources, production and quality control. To date, more than a dozen industry projects in this area have been completed or committed.

ASC has also collaborated with world-class traditional Chinese medicine (TCM) authorities at the Nanjing University of Chinese Medicine (NJUCM) and translated the book *High Performance Liquid Chromatography Fingerprinting Technology of the Commonly Used Traditional Chinese Medicine Herbs*. To date, no other book on fingerprinting traditional Chinese herbs has been published in English. The book enables TCM manufacturers worldwide to fingerprint the herbs that they sell to ensure that consumers get only quality products. The collaboration between ASC and NJUCM provides expertise to further strengthen our capability in HPLC fingerprinting.

Automated analytical instruments providing high-throughput analyses for large sample numbers

Stability Testing of Herbal Products

A study for a major TCM company is being carried out to ensure the safety and viability of their herbal products throughout their shelf lives. This is to ensure that consumers will still be purchasing a quality product some time after it has been manufactured. This is particularly important as many herbal-based products (especially in liquid form) are prone to degradation if left unconsumed over an extended length of time. This study is currently in progress, with the results intended for use by the company to ensure that all agency regulations are complied with.

Ensuring Safe Food with State-of-the-Art Liquid Chromatography-Mass Spectrometry

In collaboration with Agilent Technologies, researchers at ASC are developing a rapid screening method for determining and quantifying pesticide residues. This method is based on a state-of-the-art liquid chromatography-mass spectrometry instrument that guarantees high accuracy and reproducibility of results. This technique allows researchers to determine the amounts of several hundred types of pesticides in food products with a single analysis, and will lead to the development of a comprehensive database of all regulated pesticides in Singapore.

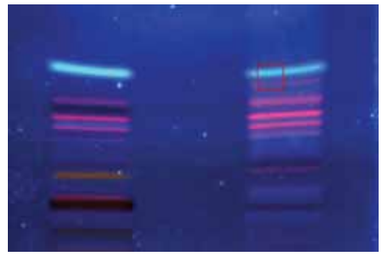
This research idea was conceptualised in 2013 when Agilent established a partnership with Temasek Polytechnic to develop enabling technologies that would be helpful for SMEs in the food industry. Pesticide analysis of food products remains one of the most challenging problems for the food industry, and the development of a rapid screening method may prove to be revolutionary for the industry.

By making use of the developed technology, regulatory agencies and SMEs will be able to significantly increase the throughput of pesticide screening for fresh and processed food products. This will not only improve the efficiency of quality testing processes in Singapore's food industry, it will do so while maintaining the accuracy, reproducibility, and overall quality of the test results.

Detection of Porcine DNA in Raw and Cooked Meat Products

A test that can be used by the food industry to increase consumers' confidence in their products has been successfully developed by our researchers. This is a reliable and sensitive method to detect porcine content in food products using DNA-based techniques. The new test "Detection of Porcine DNA in Raw and Cooked Meat Products" obtained SAC-SINGLAS accreditation in 2015. Available as a service to industry, this test method can detect porcine contamination in food. Porcine contamination can occur when there is intentional substitution of high cost meat with less costly ingredients or unintentional contamination during processing or logistics.

Raw Dendrobium herb



HPTLC chromatogram of two Dendrobium herbs

Our scientists are leading the way in research on polysaccharides from Dendrobium herbs

An Immunopotentiator from Bioactive Polysaccharides of *Dendrobium Nobile*

In recent years, polysaccharides from natural sources have been demonstrated to possess a variety of medical attributes and attracted much attention in the areas of glycochemistry and glycobiology. Due to the potential therapeutic effect and relatively low toxicity, polysaccharides from natural sources have a huge potential for pharmaceutical, food and cosmetic applications. Our researchers are leading the way with the establishment of a methodology for extracting and purifying polysaccharides from *Dendrobium* herbs. Another milestone is the discovery of two bioactive polysaccharide candidates that may be used in health supplements and functional food products. The methodologies established also apply to polysaccharides from other tropical plants. The project may lead to innovation of other value-added functional food ingredients or products.

Instrumental analyses

Development of an *In Vitro* Method to Determine the Glycemic Index of Foods Using HPLC-MS

Glycemic Index levels of food products are becoming increasingly important to consumers with blood-glucose related diseases. This has led to an increased demand for rapid and effective analytical methods for GI determination. Using Liquid Chromatography Time-of-Flight Mass Spectrometry (LC-TOF-MS), our researchers can identify potential markers in food products that may indicate its GI level. Suitable extraction and sample preparation methods are being established, followed by analysis using LC-TOF-MS. Data will be analysed to identify potential relationships between compounds and the GI of the food. *In vitro* GI determination has significant advantages over *in vivo* determination, including lower costs, decreased labour, and improved reproducibility. Currently, GI determination is a major constraint in the field of nutritional research and functional food development. The development of viable *in vitro* methodologies for GI determination will increase the pace of functional food research, translating to a larger variety of functional food products available to consumers at a lower cost.

Quality and Efficacy Studies on Upgraded Formulations of Nutraceutical Product

An SME specialising in nutraceuticals tapped on the expertise of ASC to perform efficacy studies on three improved formulations of their product. It is a well-established health and beauty product that has been sold in Singapore and other South-East Asian countries for over 10 years. Their aim when developing these three new product formulations was to refresh their product and to market it to potential consumers in different countries who had different preferences for active ingredients. The ability to revalidate the efficacy of the product after reformulation is of utmost importance.

Testimonials

“

ASC is a place of inspiration for the future. The school gives our youths a solid base of knowledge and skills to discover hidden opportunities in the space of science. Daring to dream is part of the process of discovery.

Mr Teng Chong Seng
Director, EHS
Pfizer Asia Pacific Pte Ltd

“

G5 International Holdings Pte Ltd and the School of Applied Science aim to produce bioplastics from different types of waste including wastewater through the Bioplastic Research and Pilot Plant. This innovative approach of producing bioplastics will potentially reduce the cost of such environmentally friendly plastics substantially. Working on a pilot facility contributed by G5, an attractive bioplastics production yield of more than 40% has been achieved.

Mr Terence Ong
Managing Director
G5 International Holdings Pte Ltd

“

Nestlé has a long tradition of recruiting and training young and eager adults from school. Temasek Polytechnic has allowed us to continue this tradition in Singapore through a well-crafted internship programme that produces top-notch students in the applied nutrition field. Nestlé has been a strong supporter of this programme since 2009, and will continue to collaborate with TP through student projects in GI testing.

Dr Allan Lim
Group Manager
Nestlé R&D Centre Pte Ltd Singapore

“

We are impressed by the calibre of the entire fraternity of ASC, be it the staff members or the students. We will forever be proud to remain a partner in the mutual goal to develop talent that is aligned with reality and for the future.

Mr Ang Eng Joo
Senior Vice President, Sales
WhiteRock Medical Company Pte Ltd

“

It has been a delightful journey working with the School of Applied Science at Temasek Polytechnic. I’m especially appreciative of their responsiveness and diligent response to our changing needs and those from the market. Since our partnership started, we have already reached many significant milestones, which would otherwise not be possible without the hardworking staff and support of TP’s management.

Dr Steven Fang
Founder, InvitroCue
Partner, Clearbridge Accelerator

”

Education Powered by Applied Learning

ASC's academic architecture emphasises work-based learning in the senior year during which students immerse themselves in industry-relevant elective subjects, enhanced internship and major projects. Real world environments are provided by ASC's Learning Enterprises, TP-linked Enterprises, and Centres of Excellence.

When learning is anchored in real-life situations and problems, the hands-on or practical learning experiences motivate students to learn while assisting them to develop key skills and knowledge.

Learning Enterprises

TP's guiding philosophy is to bring education to life and life to education. In full support of this aim, ASC set up the first learning enterprise, KoolWerkz, in 2005. It provides real life industry environment for students to gain practical insights into how science and technology are applied to industry operations.

TP Animal Clinic

KoolWerkz Learning Enterprise

Committed to adopting a hands-on training approach to developing entrepreneurial skills in students, ASC embarked on an innovative way of teaching students at its own off-campus training factory, KoolWerkz Learning Enterprise.

Equipped with complete ice cream-making facilities, KoolWerkz exposes students to a myriad of learning opportunities, including ice cream processing, food product development, food packaging design, process automation, process optimisation, ISO 14001 and Hazard Analysis & Critical Control Point (HACCP) certification, quality control and assurance, and sales and marketing functions, similar to real business scenarios. The skills and knowledge can be picked up as part of students' projects for various subjects, Major Projects, Student Internship Programme, Differential Research Programme as well as Cross Disciplinary Subjects.

In 2009, KoolWerkz was awarded the Certificate of Commendation by the Agri-Food and Veterinary Authority of Singapore (AVA) in recognition for consistently maintaining a high standard of food safety. This learning enterprise also clinched the Temasek Polytechnic Principal's Commendation Award for Educational Innovation in 2008 for radical innovations in student learning. The frozen desserts, which have been awarded the Healthier Choice Symbol (HSS) by the Health Promotion Board and are *Halal* certified by the *Majlis Ugama Islam Singapura (MUIS)*, are sold in some secondary schools, TP, and served to patients at Jurong Hospital.

TP Animal Clinic

Granted a licence by the Agri-Food and Veterinary Authority of Singapore (AVA) to operate a veterinary clinic, this facility enhances students' competency in veterinary assistance during pre- and post-animal sterilisations. The clinic provides training opportunities for Veterinary Technology students to learn and provide assistance to the veterinarians when they perform surgery on animals. They also help in pre- and post-anaesthesia, surgical procedures, and animal recovery.

Having a training clinic on campus provides a close-to-real-life veterinary work environment so that they become competent veterinary technologists when they work in veterinary clinics, hospitals and research animal facilities.

Village Café Social Learning Enterprise

This F&B training ground allows students to practise productivity in a real business model through the use of technology, innovative product design, and effective cost control. As a learning enterprise, it is also designed as a platform to translate learning from the classroom into a tangible form, and to provide the environment where students' ideas can be commercialised. With the experience of operating a real enterprise, students are better prepared for the industry.

The 80-seater café opened on 13 July 2015. It follows a quick service café concept, serving quality East-meets-West fusion food for breakfast and lunch.

Agilent Partner Lab@TP

Village Café Social Learning Enterprise @GCV

TP-Linked Enterprises

With our experience in setting up several learning enterprises since 2005, ASC has taken another step in its collaboration with industry partners by establishing TP-linked enterprises, where applied learning is embedded within full-fledged commercial enterprises. These TP-linked enterprises have opened up more opportunities for staff to work on industry-relevant projects and develop appropriate technical competencies to help keep ASC's student training updated and industry-relevant.

Agilent Partner Lab@TP

This Lab brings together cutting-edge chemical, analytical and bio-analytical technologies from Agilent and resources from TP to help businesses, in particular those that develop, manufacture or distribute traditional medicine and food products. Chemists at this Lab are able to conduct tests to screen, detect, identify and quantify chemicals in ingredients and products at various stages of the chain – from product innovation to quality control, from trace substance screening and identification to product authentication.

TP-Apollo Live Feed Research & Production Centre

ASC is partnering APOLLO Aquarium, one of the oldest ornamental fish farms with more than 40 years' experience in the ornamental fish trade. The partnership has resulted in the establishment of a live feed R&D lab for both freshwater fish and marine foodfish fry. The joint partnership between APOLLO and ASC would eventually lead to a scale up of the live feed production for commercialisation to both local and regional fish farms in the near future.

Being a one-stop centre for aquaculture R&D, ASC adopts an industry-centric approach in addressing the needs of both freshwater and marine food fish sectors. A collaboration such as this helps companies to innovate and stay competitive in the aquaculture industry.

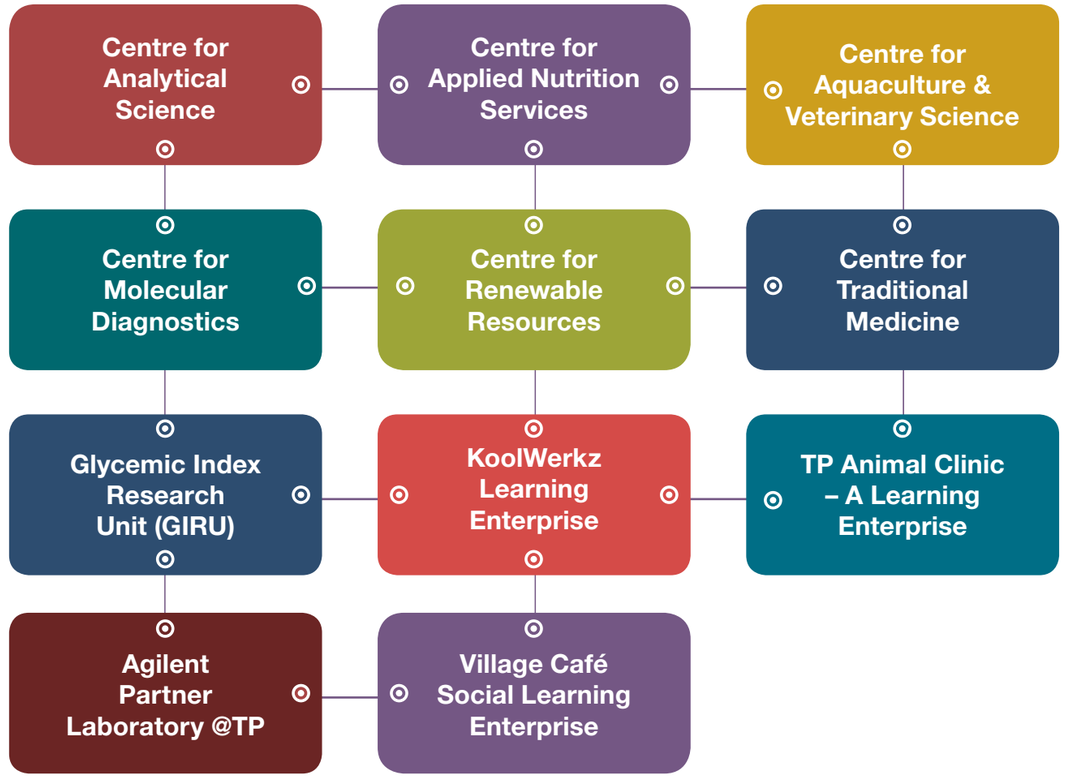
Ubin Aquaculture Research Station

ASC and Lubritrade Ocean (Ubin) are collaborating to enhance farm productivity and management. By setting up an on-site research station with ASC, Lubritrade Ocean can leverage on the Research & Development capabilities of ASC to better manage the health and nutrition of food fish.

The research station, an actual aquaculture field laboratory in an off-shore fish farm setting at sea, is the first of its kind for a polytechnic. ASC has the advantage of accessing 500m^2 of farm space and work closely with the farm for conducting field trials. The natural sea water conditions in net cage farming provides excellent test-bed conditions for ASC to do translational aquaculture research. This also enables ASC to develop more realistic solutions to address the needs of the local fish farmers.

Centres of Excellence & Key Facilities

ASC's Centres of Excellence are set up for staff and students to engage in key applied research activities in chemical and life sciences within the school. The Centres' state-of-the-art facilities promote inter-disciplinary research among staff and collaborative work with the industry and institutions of higher learning. In doing so, staff continue to upgrade their skills in the relevant technical competencies, in support of ASC's vision to be the Biofactory or one-stop centre for industry to transform their ideas into products or services. The Centres of Excellence also serve as training ground for students as they work alongside staff to apply their knowledge and skills in applied industry projects.



Testimonials

Partnering TP and tapping into its R&D-enabling Biofactory facilities and services, including validation, standard and IP development bring real added commercial value to my work. It also helps me pitch the position of using Singapore's holistic ecosystem as a business-enabling gateway to ASEAN markets and beyond.

Mr Teng Theng Dar
Singapore's Non-Resident Ambassador to Oman
Founder, Business Compass Consultancy

ASC has offered us great help in the development of a suitable live feed for the ornamental fish industry. We are grateful for the invaluable advice and also the research outcome from the project. We look forward to greater collaboration with ASC in other new projects that can translate into important applications for the aquaculture industry.

Mr Lim Meng Huat
Chief Operating Officer
Apollo Aquarium Pte Ltd

Recycling of aggregate fines, a valuable by-product from our plant, would potentially help to create another high-value revenue stream for our company. Thank you SPRING and ASC!

Mr Oh Siong Huat
Director
Yun Onn Company Pte Ltd

ASC and our company have been working collaboratively on various projects such as chemical fingerprinting and quality assessment of our herbal products since 2007. We are extremely pleased with the services provided by ASC. Their support and expertise have enabled us to improve and innovate not just in our processes, but also our production techniques. We are also able to use the stability test report as a requirement for exporting our products overseas. Based on the success of past projects, there is definitely going to be more collaboration in the future!

Mr Yeo Kay Yong
Managing Director
H.W. Traditional Medicine Pte Ltd

In Industry — For Industry

We begin the RIE journey with the end in mind. As such, innovations are brought from bench to market at a relatively fast pace.

Enterprise Development @ASC

The product development process at ASC typically goes through these stages:

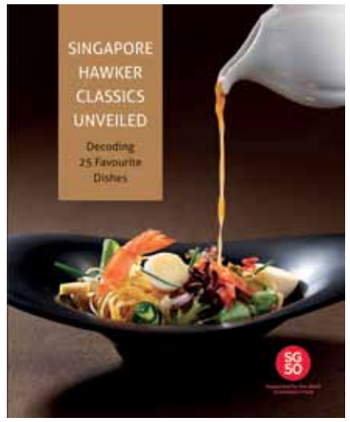
Every project is purposefully designed for ultimate deployment. In the event that things do not work out as intended, the project is terminated and the learning experience transferred to initiate another idea to address the problem statement differently.

Our successful innovations derived through collaborative R&D and student projects can be categorised into either products for day-to-day living, products with industrial application, or accredited testing services. Products for day-to-day living will be available in 2016 through our very own store located at the Centre for Aquaculture & Veterinary Science. Named the ***InnovStore***, this is where one can find products developed at ASC, as well as books authored/co-authored by our staff.

Seasonal products for industrial/commercial applications are currently at the beta-testing stage by industry partners. These include point-of-care diagnostic products for food toxin detection, and a 3-in-1 wound dressing.

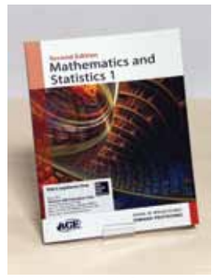
Test methods are optimised at ASC and offered as a service to the industry. ASC also offers consultancy services to the industry for new product/process development.

Books

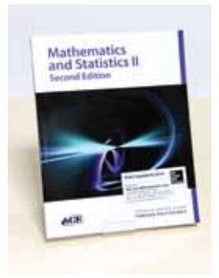


Singapore Hawker Classics Unveiled

High Performance Liquid Chromatography Fingerprinting Technology of the Commonly Used TCM Herbs



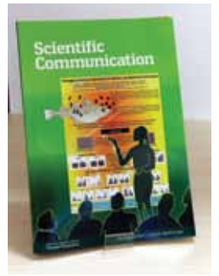
Mathematics & Statistics I



Mathematics & Statistics II

'THE' Metabolic Biochemistry

Effective Communication



Scientific Communication

InnovStore logo by Maryam Didih, Year 3 (2015)

KoolWerkz Frozen Dessert

TPel Organic Insect Repellent

Protein Discovery Kit

Souvenir tiles made from Engineered Cementitious Composite

Park bench made from Engineered Cementitious Composite

Animal Wellness Facility logo by Amirah Osman, Sabrina Raimi, Hao Zhuang, and Ahmad Zuheir, Year 2 (2015)

Animal Wellness Facility

The upcoming **Animal Wellness Facility** will provide students with experiential learning related to animal wellness, veterinary care and support for pet animals mainly dogs. It will be housed in the Centre for Aquaculture and Veterinary Science which will be operational in mid-2016.

Various treatments for pets are offered at the Animal Wellness Facility

Consultancy & Analytical Services

Applied Nutrition Research & Consultancy Services

- Diet/Nutrition surveys
- Menu planning & evaluation
- Nutrition assessment & nutrient analysis
- Nutrition intervention
- Sports/Performance nutrition

SAC-SINGLAS Accredited Chemical Testing

- Alcohol (drinks/beverages)
- Heavy metals (TCM)
- Nutrients

SAC-SINGLAS Accredited Biological Testing

- Microbiological
- Porcine DNA (in processed food)

SAC-SINGLAS Accredited Functional Food Testing

- Glycemic index testing

Functional Testing

- Antioxidant
- Particle filtration

Materials Testing

- Ultrasonic pulse velocity (UPV)
- Flexural strength
- Toughness
- Impact
- Thermal conductivity
- Toxicity characteristic leaching test (TCLP)

Pharmaceutical Testing

- Stability
- Friability
- Hardness
- Dissolution

Consultancy & Product / Process Development

Innovative Food Product & Process Development

- Product development (noodles, frozen dessert, beverages, low GI products, baked products, etc)
- Process optimisation
- Food preservation
- Shelf-life and product stability testing
- Food safety

Processing Technologies for Food and F&B Industries

- Culinary & baking application
- Recipe development
- Technology-based food production to enhance product quality & production efficiency

Materials Development

- Recycling of solid waste into building materials
- Mix formulation enhancement
- Geopolymer development
- Magnetic & photocatalytic nanomaterials development

Water Treatment

- Design of wastewater treatment solutions
- Design of water recycling solutions
- Technical feasibility studies
- Optimisation studies

Test Kit Development

- Biochemical assay kits
- Molecular diagnostics for point-of-care (POC) applications

Pharmaceutical/ Nutraceutical Product Development

- Solid, liquid, semi-liquid dosage formulations

Other Areas of Consultancy and Service

- Animal trials
- Clinical trials
- Product shelf life
- Pathogen detection & identification
- E-learning training packages
- Food safety training packages
- Institutional Review Board (IRB)

ASC & the Industry

We are in industry, for industry.

Our close partnership with various industry sectors has been instrumental in ensuring the relevance of our programmes, our students and our staff. We constantly seek synergy that will bring benefits to both parties in areas such as collaborative R&D projects, joint training programmes, staff attachments, consultancy, student internship programmes and job placements.

MOU signing between ASC and Singapore Accreditation Council

These strategic alliances ensure we have a finger on the pulse, and keep our staff and students close to industry's best and latest practices. Some of our current key partners include:

MOU with Agilent Technologies

MOU with Apollo Aquarium

MOU with Lubritrade Ocean (Ubin) Pte Ltd

Agilent Technologies Singapore (Sales)

To help SMEs maintain strict safety and quality standards, we have collaborated with Agilent Technologies and set up the Agilent Partner Laboratory @TP. Using the latest technologies from Agilent, our team at ASC will be able to conduct tests to detect, screen, identify and quantify chemicals in ingredients and products. SMEs, in particular those in the food and traditional Chinese medicine industry, will have easy access to services ranging from product innovation to quality control, from trace substance screening and identification to product authentication.

Agri-Food and Veterinary Authority of Singapore (AVA)

TP works with AVA in helping the local foodfish farmers in crisis management planning against algal blooms which are becoming more common due to climate change. ASC and AVA jointly conducted the first one-day farm crisis management course in 2015. ASC will be working with individual farms in manpower training and farm crisis management planning using funding support from SPRING Singapore under the Innovation Capability Voucher Scheme.

Apollo Aquarium

Our team of researchers is making significant headway in their work on the development of live feeds. Partnering us in this area is Apollo Aquarium. As there is no local producer and supplier of live feeds, ASC has teamed up with Apollo Aquarium in forming a Live Feed R&D and Production Centre. Apollo Aquarium will scale up the live feeds for commercialisation.

Centre for Environment, Fisheries and Aquaculture Science (CEFAS)

CEFAS is the executive agency of UK's Department for Environment, Food and Rural Affairs (DEFRA). It serves to ensure that marine and freshwater environments are safe and secure through scientific research, providing evidence-based scientific advice and facilitating international collaborative relationships. CEFAS has signed a Memorandum of Understanding (MOU) with ASC and will collaborate on areas such as research on aquatic health and diseases, joint seminars and workshops as well as staff exchange or attachment. Currently, TP is the first and only polytechnic to have an off-shore aquaculture research station at a floating foodfish farm, where students apply what they learn about aquaculture, aquatic care and disease control/prevention, farm operation and management at the farm.

Danone Asia Pacific Holdings / Danone Nutricia Research

A Research Agreement has been signed with Danone, covering the development of a food list and quantifying portion sizes for Singaporean toddlers.

Danone Dumex Malaysia

Danone Dumex Malaysia and the Glycemic Index Research Unit signed a Research Agreement to test the glycemic index and glycemic response of 10 food products.

Danone Dumex Singapore

We have a Research Agreement with Danone Dumex Singapore to study the dietary habits of children from one to six years old.

Diabetic Society of Singapore (DSS)

DSS signed an MOU with TP to promote joint research and development, and academic activities of mutual interest, in accordance with their respective needs and objectives. TP has been assisting DSS' community outreach events such as public forums, diabetic camps, workshops and the annual World Diabetes Day.

Fisheries Research Institute of Shizuoka Prefecture, Japan

The Fisheries Research Institute of Shizuoka Prefecture (FRISP) signed an MOU with TP to collaborate in research and development in areas related to disease diagnostics, broodstock development and other areas of interest related to nutrition. Apart from R&D activities, ASC staff are attached to FRISP for hands-on training and field trips to sea food farms.

MOU with Kei-Y Corp

MOU with Institution of Aquaculture Singapore & Singapore Institute of Engineering Technologists

G5 International Holdings

Our collaboration with G5 International Holdings Pte Ltd focuses on the development of bioplastics. The collaborative research involves the setting up of a pilot bioplastics facility in ASC by G5, and the operation and optimisation of this facility.

Griffith University, Australia

Our MOU with Griffith University covers student and staff exchange, and overseas study trips with Griffith School of Pharmacy. Using the MOU as a platform, staff from Griffith University will provide guest lectures through tele-broadcasting or in person. ASC and Griffith will also be developing teaching materials using Griffith's state of the art e-platform.

H.W. Traditional Medicine

Our collaboration with H.W. Traditional Medicine Pte Ltd provides opportunities for industry consultancy projects in herbal product quality and safety, as well as joint activities in areas such as toxicological studies of TCM products. The partnership also provides staff industry attachment and student internship opportunities with H.W. Traditional Medicine Pte Ltd and includes the sponsorship of scholarships for ASC students.

Institution of Aquaculture Singapore

ASC signed an MOU with Institution of Aquaculture Singapore to enhance the scope of aquaculture research and training. The MOU covers joint research and publications, student and staff training, competency certification, sponsorship of book prizes and course medals, as well as aquaculture training for the industry.

Collaboration Agreement with Invitrocue

The signing of the collaboration agreement with Invitrocue Pte Ltd provides opportunities for TP and Invitrocue to conduct joint activities related to *in vitro* hepato toxicity screening services to the industry to enable preclinical and early stage drug development. *In vitro* screening identifies compounds for their potential toxicity before the expensive full product development cycle, and will save companies thousands of dollars in development costs. InvitroCue's 3D *in vitro* models are applicable in this early phase of product development.

Kei-Y Corporation

Kei-Y Corporation Pte Ltd and TP signed an MOU to embark on joint research in diabetes management. The first project studies cyclical pressure adaptation in diabetic mouse models. It is carried out by the Veterinary Technology team at ASC.

Lubritrade Ocean (Ubin)

To enhance farm productivity and management, ASC and Lubritrade Ocean (Ubin) Pte Ltd signed an MOU, resulting in the first-of-its-kind aquaculture field laboratory in a commercial farm setting at sea. ASC has the advantage of accessing 500m^2 of farm space and work closely with the farm to conduct field tests, while Lubritrade Ocean can leverage on the R&D capabilities of ASC to better manage the health and nutrition of fish food.

Merck, Sharp and Dohme Animal Health Innovation

Under a Masters Agreement with Merck, Sharpe and Dohme (MSD) Animal Health Innovation, ASC has been appointed as one of their diagnostic testing arms for pathogen detection in fish and shrimp samples from local and regional farms. This will strengthen our capability building for research, education and services for the aquaculture and veterinary industries.

MOU with Nanjing University of Chinese Medicine

MOU with Oceanus Group

Nanjing University of Chinese Medicine, China

ASC is in collaboration with Nanjing University of Chinese Medicine to expand its scope of consultancy services and R&D capabilities in herbal research. The collaboration provides for joint projects on HPLC profiling of herbal preparations as well as staff and student exchange. The collaboration also led to the publication of the book, *High Performance Liquid Chromatography Fingerprinting Technology of the Commonly Used Traditional Chinese Medicine Herbs* in English.

Nestec

Nestlé's new extension to its research and development centre in Singapore will allow greater focus on its fastest-growing markets in the Asia-Pacific region. The centre has gained deep expertise in South and Southeast Asian cuisine and cooking techniques through extensive consumer research over the past 30 years. Nestec has been working with TP on Glycemic Index research and testing since May 2013.

Oceanus Group, China

Oceanus Group Ltd is a Singapore listed company and the largest land-based abalone producer in China with an annual production of 137.9 million abalones using the tank system. Oceanus signed an MOU with ASC to conduct research in improving the quality and production of abalone. Apart from research, staff attachment and student internship also form part of the MOU.

Philips Electronics Singapore

As part of TP and Philips' MOU to build long-term strategic collaboration, a set of ten local noodle-based recipes were specially developed by ASC's Diploma in Baking & Culinary Science and marketed with the Philips Noodle Maker. The noodle-making machine is the first project launched under the MOU.

Sembcorp EOSM

The Green Materials Sustainable Development Centre consists of a pilot scale fabrication facility at Sembcorp EOSM and a laboratory scale fabrication and testing facility at ASC. For green materials to be commercialised, larger sized prototypes have to be cast and tested. The MOU with Sembcorp EOSM will facilitate the testing of actual sized specimens, and adoption of such alternative materials by the industry. Moreover, it will facilitate technical exchanges through joint R&D projects between the company and ASC, hence catalysing the development of ASC's competency in green materials development.

Singapore Institute of Engineering Technologists

The MOU with Singapore Institute of Engineering Technologists seeks to enhance the scope of aquaculture research and training, covering joint research and publications, student and staff training, competency certification, sponsorship of prizes and course medals, and aquaculture training.

Singapore Accreditation Council

An MOU between ASC and Singapore Accreditation Council (SAC), SPRING Singapore, covers various areas including staff attachment, student internship, as well as the conduct of a Continuing Education Training course, the *Specialist Diploma in Laboratory Management and Instrumentation*. The course will enable employees to upgrade and update their competencies in analytical instrumentation and laboratory management work.

Ishikawa San of Yaizu Suisankagaku Industry with Baking & Culinary Science students

MOU with WRS

Singapore Police Force (SPF)

ASC's collaboration with the Home Team School of Criminal Investigation (HTSCI), a unit of the SPF, enters its third year, with the enrolment of 26 applicants to the Diploma in Applied Science (Forensics). The course equips participants with necessary scientific knowledge and skills to be able to collect, analyse and interpret forensic evidence, and promotes the awareness of key trends and issues that impact the field of forensic science.

Southern Taiwan University of Science and Technology (STUST), Taiwan

An MOU signed with Southern Taiwan University of Science and Technology (STUST) benefits not only Pharmaceutical Science students, but also students from the Chemical Engineering and Biotechnology course. STUST has well-established departments in Chemical and Materials Engineering, Biotechnology and Nanotechnology. The MOU will also help ASC further develop its Nanotechnology capabilities through joint research projects.

Temasek Foundation CLG (Temasek Foundation)

The Temasek Foundation has awarded TP a one-time grant of $223,430 to enable ASC to offer the Temasek Foundation-Temasek Polytechnic Public Health Care Nutrition Leaders/ Specialists Programme in Lao PDR, in collaboration with the Ministry of Health over a three-year period.

Transalgae Israel, Israel

The research collaborative agreement between ASC and Transalgae Israel makes TP the first teaching institution to sign such an agreement with a biotechnology research company from Israel, with funding supported by the Singapore-Israel Industrial R&D (SIIRD) Foundation. The grant covers ASC's R&D involvement in the joint project on the development of oral fish vaccine against iridovirus for seabass. The successful development of the product would eventually lead to local and regional commercialisation.

University of Applied Sciences, Utrecht, Netherlands

An MOU was signed with UTRECHT covering joint research, overseas student internship programme and staff attachment / exchange.

Wildlife Reserves Singapore (WRS)

ASC signed an MOU with WRS to collaborate in veterinary research, diagnostic testing and training. Under the agreement, ASC will be developing low-cost, user-friendly diagnostic tools or laboratory testing method for on-site diagnostic testing as part of WRS's exotic animal care and management programme. WRS will also be providing structured internships for ASC students.

Yaizu Suisankagaku Industry (YSK), Japan

Our partnership with Japanese listed company Yaizu Suisankagaku Industry opens up opportunities for research collaborations, internships, and staff and student exchange. This is the first time YSK is collaborating with an organisation outside Japan. The initial focus of the collaboration is on antioxidants in marine-based sources, as well as food recipe development. Product development for the ASEAN market, catering to local tastes and preferences, will also be undertaken.

Reaching Out — Touching Lives

Our classroom extends far beyond the gates of the campus, into the HDB heartlands and to faraway places such as Cambodia and Paris. In addition to a rigorous academic curriculum, our students experience the real world where they learn to care, share and serve the wider community.

Through a wide range of community involvement programmes, we provide opportunities for students to use their skills and talents for the greater good.

The BCS Team in Paris

Serving Hawker Fare in Paris

Serving Hawker Fare at the Banks of River Seine in Paris

Nine staff members and 43 students from the Diploma in Baking and Culinary Science (BCS) cooked up a feast of signature hawker dishes during the four-day *Saveurs de Singapour sur les Berges de Seine*, a Singapore street hawker event that was part of the *Singapour en France – le Festival*, from 18 to 21 June 2015. Celebrating 50 years of Singapore-France diplomatic relations and Singapore's Golden Jubilee, the festival was a showcase of Singapore's contemporary arts, culture and heritage in Paris, France. The event was co-produced by the National Heritage Board.

Visitors chose from popular hawker delights such as *chicken rice*, *bak kut teh, mee goreng, satay, chendol* and *bandung*. Though the tourist venue had a daily crowd of over 10,000 visitors, over 6,000 portions of those 5 dishes were prepared and sold. The students endured a week-long crash course on Asian cuisine and put their skills to the test during the festival. With a limited supply of local ingredients available in Paris, one challenge faced was recreating that authentic local flavour. The event received an overwhelming response from the locals as well as Singaporeans living in France, with some 6,000 people showing up to enjoy the hawker favourites prepared by the BCS students and staff.

For the BCS students, this overseas experience to France was arranged and presented as a Cross Disciplinary Subject (CDS) called Global Citizenship. The study trip was not only for the students to experience French culture and lifestyle, it was also intended to heighten students' awareness of our unique and dying hawker food culture.

Helping Hand in Health Matters

This is a community outreach project by students in collaboration with FILOS Community Services Ltd. Involving students from the Diploma in Biomedical Science and Diploma in Pharmaceutical Science, the project is supported by the MOE SG50 Giving initiative that provides funds to enable students to support meaningful causes in the community.

Two training sessions were held covering topics such as dementia and depression, as well as communication skills. Students conducted house-to-house visits to share educational information on common health conditions and taking medicines safely. They handed out goodie bags containing educational materials, coupons for fruit hampers, and daily necessities.

This experiential learning activity was used to fulfil the *Leap in Action* component of the core module *Leadership: Essential Attributes & Practice.*

Public Healthcare and Nutrition Intervention Programme in Lao PDR

Temasek Polytechnic, Temasek Foundation and the Ministry of Health of Lao PDR have initiated a three-year capacity building training programme on Public Healthcare and Nutrition Intervention. Trainers from ASC shared our knowledge in nutrition intervention with public health and nutrition officials from schools, hospitals and health centres across Lao PDR. Over the next two years, 100 public health and nutrition officials will learn about health and nutrition related knowledge, such as meal planning, healthier meal preparation, health education and illness prevention. This will enable them to train health educators and school teachers on ways to design healthier and more nutritious meals in schools.

In addition to this, participants will be able to use their knowledge on nutrition assessment to carry out basic nutrition assessment to monitor the health status of the target groups, identified by the Ministry of Health of Lao PDR. The 100 participants will also share their knowledge with another 200 of their peers, thus extending the impact of the programme to a wider community.

The one-week training in Lao from 14 to 18 December 2015 focused on maternal and child nutrition, while the subsequent two-week training held in Singapore in March 2016 covered nutrition issues for the other stages of the lifespan.

Public Health & Nutrition Intervention Programme in Cambodia

MOU with Lao PDR

Public Health & Nutrition Intervention Programme in Cambodia

The Temasek Foundation-Temasek Polytechnic Public Health & Nutrition Intervention Programme, conducted from 2011 to 2014, addressed the problem of malnutrition amongst mothers-to-be in Cambodia. Focusing on maternal and child nutrition, staff and students from the Diploma in Applied Food Science & Nutrition trained 150 officials from the Ministry of Women's Affairs and community health educators from various provinces in Cambodia over the four years.

Participants were taught the basics on how to assess the nutritional status of pregnant women and children, as well as how to modify recipes to make them healthier using local produce. They also learnt how to improve diet quality during pregnancy, breastfeeding and weaning.

The opening ceremony and signing of the MOU held on 24 February 2011 was attended by Cambodia's Minister for Women's Affairs. Subsequently, in 2011, 2012 and 2014, the team conducted one-week training sessions in Phnom Penh, attended by 50 officials from the Cambodian Ministry of Women's Affairs and a few community health educators from a local NGO.

To ensure the knowledge was imparted to the villagers, staff conducted follow-up provincial visits. Each Cambodian participant was required to train another five, creating a multiplier effect. Over three years, about 750 Cambodians were trained. Thirty participants were eventually shortlisted to attend a two-week Certificate Programme in Food Science & Nutrition in Singapore, held from 27 October to 7 November 2014.

20 students from the Diploma in Applied Food Science & Nutrition and the Diploma in Consumer Science & Technology supported the training as part of their overseas service learning programme. Academic instruction, meaningful service, an on-site community immersion experience and critical reflective thinking were combined to enhance their learning and sense of social responsibility. Over the three years, 60 students participated in the programme.

Building a Sustainable Community in Batam

As part of their Sustainable Community Development cross-disciplinary module, 15 Biotechnology and Veterinary Technology students went on an Overseas Community Programme to Batam. There, they shared their knowledge of Science and sustainable development with 61 children and teenagers from the Yayasan Radmila Children's Home (YRCH). They planned, developed and implemented their community development action plan, helping their young friends to grow vegetables and rear catfish.

YRCH had requested for Science lessons as they believe that Science is an important area to help their children become independent and employable in the future. The project thus focused on Science education as a tool for sustainable community development, with reference to YRCH's vegetable garden and fish ponds.

By adopting ASC's fish pond proposal, YRCH finally reared three to four kinds of fish and also grew lotus plants in the ponds. They also committed to using sustainable environmentally friendly methods - composting and garbage enzyme - to increase their vegetable garden yield. Finally, mini Science laboratory sessions were incorporated into the school curriculum and the staff expressed eagerness to incorporate teaching-learning materials in future Science lessons.

Mini Hawker Food Roadshow at Secondary Schools

Public Healthcare and Nutrition Intervention Programme in Lao PDR

Mini Hawker Food Roadshow at Secondary Schools

The Baking & Culinary Science team went on the road to secondary schools with their newly published cookbook, *Singapore Hawker Classics Unveiled: Decoding 25 Favourite Dishes*. The team shared with secondary school students our Singaporean food heritage, and the techniques of cooking these local favourite dishes. The outreach activity also had the goal of introducing the exciting world of culinary science to students.

The cookbook is ASC's first commemorative coffee-table cookbook to celebrate two major milestones - SG50 and TP's 25th Anniversary. The production of the book was triggered by Prof Tommy Koh who, as Chairman of the National Heritage Board in 2010, had called for hawker food to be taught in culinary schools so as to preserve the integrity of our hawker dishes. The book publication is supported by the SG50 Committee and the Heritage Participation Grant (HPG) of the National Heritage Board (NHB).

Produced by the staff and students from the Diploma in Baking & Culinary Science, this cookbook captures the essence of 25 popular hawker dishes in a nutshell. It features the brief history of each dish and its variations, tested recipes with illustrations on important steps, sensory description and scientific explanation of the recipe ingredients or cooking techniques, as well as the nutritional value of the dishes.

Held from September 2015 and targeted to run till March 2016, the roadshows have so far received positive feedback from secondary school students and teachers who enjoyed the computer games with SG50 giveaways, and the culinary science demonstrations.

Reaching Out to Seniors: Healthy Eating Talk

Final year students from the Diploma in Applied Food Science & Nutrition hosted seniors at a Healthy Eating Talk jointly organised by Temasek Polytechnic and the Diabetic Society of Singapore on 30 August 2014. A total of about 120 seniors, aged 50 and above, from the Lions Club were invited to the event.

Posters and food models were exhibited and our students and staff interacted with the seniors to emphasise the importance of healthy eating. In addition, our staff member who is also a nutritionist presented a talk on food labelling and healthier food choices. Each of the seniors left with a loaf of low GI multi-grain bread from our sponsor, and most importantly, a practical understanding of healthier eating choices.

Promoting the Use of Safe Medication among Seniors

Staff and students from the Diploma in Pharmaceutical Science partnered the North East Community Development Council (NECDC) in a project targeted at elderly residents. The project promoting the safe use of medications amongst elderly residents allowed students to apply their knowledge and skills, and expand their experience beyond the classroom. Staff advisors from the School of Applied Science are trained Pharmacists with a wealth of experience in the area of community healthcare education.

The outreach programme was conducted as a door-to-door community health education exercise. The teams conducting the education visits included students from the Diploma in Pharmaceutical Science, as well as alumni volunteers and adult volunteers identified by NECDC and associated community help agencies.

During the door-to-door visits, volunteers reviewed the seniors' current habits on the use, storage and organisation of medications, and their access to healthcare advice and timely medication supply. The volunteers also provided explanation on the safe use of medications, encouraging timely referral for professional healthcare advice and medication supply.

Testimonials

"

The collaboration between Dawyn International Pte Ltd and ASC started in 2006. By leveraging on ASC's R&D competencies in Life Science and Analytical Science, our company has benefited tremendously from this partnership. For example, we are able to gather important scientific data and evidence on the efficacy of a product at a very much lower cost, than if we were to conduct clinical studies. So, based on the success of past projects, we look forward to even more challenging areas of collaboration in future.

Mr David Lim Heng Huat
Chairman/CEO
Dawyn International Pte Ltd

"

Hi En LLP tapped on the technical expertise of the Glycemic Index Research Unit team at ASC. With their help, we created a 'guilt-free Low GI Quinamie Bar' that does not compromise on taste, but provides wholesome goodness for anyone, anytime, and anywhere with sustained energy release. ASC's capability has created a winning market edge for our products!

Ms Sun Yuen Peng
Director
Hi En LLP

"

AVA and ASC are integral partners who share the same mission of raising the standard of aquaculture in Singapore. We commend the commitment of ASC staff to develop new training programmes such as our recent joint project on farm contingency planning. We plan to work closely with ASC in future, and will jointly participate in emergency situations such as plankton bloom crisis in response to the needs of the farmers. Our partnership is uniquely placed to facilitate the sharing of best practices, and this can only benefit the aquaculture industry.

Mr Foo Siang Ming
Group Director
Technology & Industry Development Group
Agri-food and Veterinary Authority

"

Facts & Figures

Profile of Staff

	2010	2011	2012	2013	2014	2015
PhD	24	32	37	45	51	56
Masters	43	46	49	48	46	47
Bachelors	36	43	44	52	47	46
Diploma	13	18	17	24	27	27
Others	5	5	5	5	5	6
Total	121	144	152	174	176	182

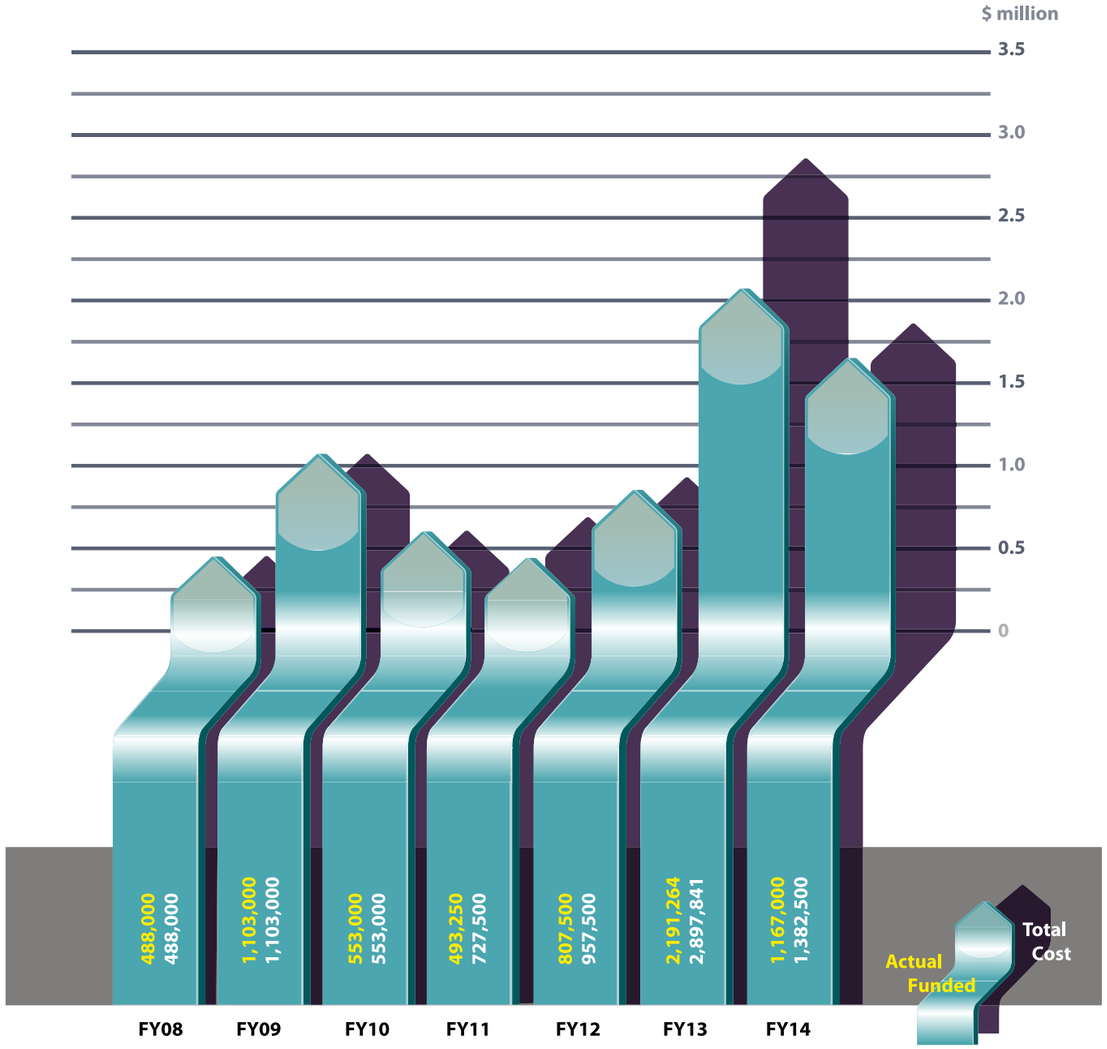
Student Enrolment

	AY2010 / 2011	AY2011 / 2012	AY2012 / 2013	AY2013 / 2014	AY2014 / 2015	AY2015 / 2016
Diploma in Applied Food Science & Nutrition	314	338	361	375	370	342
Diploma in Baking & Culinary Science	143	144	143	142	141	129
Diploma in Biomedical Science	241	176	158	152	144	143
Diploma in Biotechnology	308	299	294	290	286	273
Diploma in Chemical Engineering	422	439	432	437	453	464
Diploma in Consumer Science & Technology	66	63	64	53	36	13
Diploma in Pharmaceutical Science	147	243	288	324	324	314
Diploma in Veterinary Technology	154	156	146	146	144	148
Total	1,795	1,858	1,886	1,919	1,898	1,826

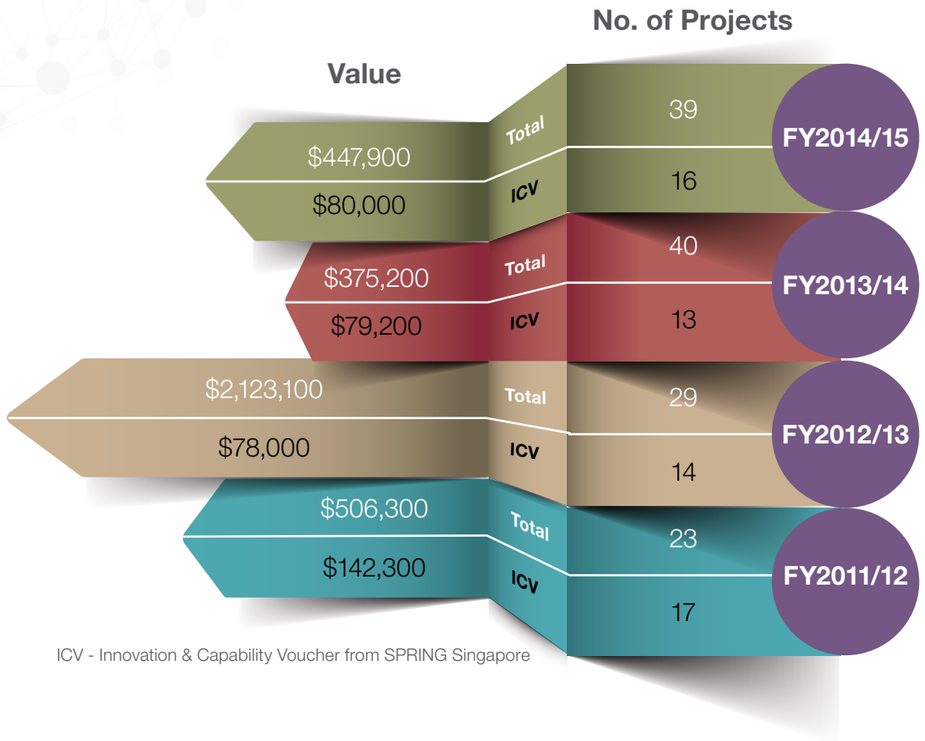
Profile of Graduates

	AY2010 / 2011	AY2011 / 2012	AY2012 / 2013	AY2013 / 2014	AY2014 / 2015
Diploma in Applied Food Science & Nutrition	93	100	103	121	114
Diploma in Baking & Culinary Science	41	49	40	43	49
Diploma in Biomedical Science	119	66	54	53	48
Diploma in Biotechnology	104	95	94	94	94
Diploma in Chemical Engineering	121	139	135	135	134
Diploma in Consumer Science & Technology	17	22	20	19	23
Diploma in Pharmaceutical Science	NA	62	72	105	103
Diploma in Veterinary Technology	38	57	46	47	43
Total	533	590	564	617	608

External Research Grants



Consultancy Projects



ICV - Innovation & Capability Voucher from SPRING Singapore

With Gratitude

We would like to acknowledge with much appreciation, the crucial role of the School Advisory Committee in steering the school forward and helping us to grow. Your insights, observations and rich experience have been invaluable in our endeavour to provide excellent training for young and adult learners, and developing them into the best professionals in their fields.

We thank you too, all industry partners, who have generously shared your experience and provided guidance to our staff and students over the years. Your involvement in helping to shape the quality of our students is deeply appreciated. We look forward to a continued partnership with you in the years to come.

Our Partners & Collaborators

1. 3D Matters
2. 3M
3. Aalst Chocolate Pte Ltd
4. Ace Trading and Management Services Pte Ltd
5. Agilent Technologies Singapore (Sales) Pte Ltd
6. Angliss Singapore Pte Ltd
7. Apollo Aquarium Pte Ltd
8. Agri-Food and Veterinary Authority of Singapore
9. Aquacultural F.A.M.E. (S) Pte Ltd
10. AquaRes Technology Pte Ltd
11. A*STAR Biopolis Shared Facilities
12. Auric Pacific Marketing Pte Ltd
13. Bakels Singapore Pte Ltd
14. BD Biosciences
15. Bio3D Technologies Pte Ltd
16. Blue Aqua International Pte Ltd
17. Business Compass Consultancy
18. California Raisins
19. Centre for Environment, Fisheries And Aquaculture Science, UK
20. Changi General Hospital
21. Chew's Group Limited
22. Coca Cola Singapore
23. Dana Products Inc
24. Danone Asia Pacific Holdings Pte Ltd
25. Dawyn Impex Pte Ltd
26. DHI Water & Environment (S) Pte Ltd
27. Diabetic Society of Singapore
28. DSO National Laboratories
29. Dynaglass Reinforced Plastic Pte Ltd
30. DynaLynk Pharma Pte Ltd
31. Economic Development Board
32. Eco-Wiz Group Pte Ltd
33. Environmental Health Institute
34. Eu Yan Sang (S) Pte Ltd
35. Fairmont Hotels and Resort
36. Fishery Research Institute of Shizuoka Prefecture, Japan
37. Fresh Direct Pte Ltd
38. G5 International Holdings Pte Ltd
39. Gardenia Foods (S) Pte Ltd
40. GeneSing Technologies Pte Ltd
41. GlaxoSmithKline
42. Griffith University
43. Harbin Medical University
44. Health Promotion Board
45. Health Science Authority
46. Herbalink Pte Ltd
47. Herbal Life Asia Pacific Services Ltd
48. Huay Feng Hang Pte Ltd
49. H.W. Traditional Medicine
50. Innoheart Pte Ltd
51. International Enterprise Singapore
52. Institution of Aquaculture Singapore
53. Institute of Bioengineering and Nanotechnology
54. Institute of Infocomm Research
55. InvitroCue Pte Ltd
56. IPI Singapore
57. Islamic Religious Council of Singapore
58. Japan External Trade Organisation (JETRO)
59. Jiangnan University
60. JR Foods Pte Ltd
61. Jurong Health Services Pte Ltd
62. Kim Sin Medicine Manufactory Pte Ltd
63. KK Women's and Children's Hospital Pte Ltd
64. Kei-Y Corporation Pte Ltd
65. Kovax Ltd
66. Leading Bioenergy (S) Pte Ltd
67. Le Choix Pte Ltd
68. Lubritrade Ocean (Ubin) Pte Ltd
69. Lynk Biotechnologies Pte Ltd
70. Mandrake Medical Pte Ltd
71. Marine Life Park
72. Martin Braun Southeast Asia Pte Ltd
73. McGraw-Hill Education (Asia)
74. Merck, Sharp and Dohme Animal Health Innovation Pte Ltd
75. MesoPhase Technology, Inc
76. Montreux Patisserie Pte Ltd
77. Mount Pleasant Animal Medical Centre Pte Ltd
78. Nanchang University
79. Nestec Ltd
80. Nestlé Professional Singapore
81. Nestlé R&D Centre (Pte) Ltd
82. Nanjing University of Chinese Medicine
83. Nanyang Technological University
84. National Environment Agency
85. National Heritage Board
86. National Research Foundation
87. National University of Singapore
88. NAVA 1872 Pte Ltd
89. Norwegian Seafood Council
90. North East Community Development Council
91. NU International Singapore Pte Ltd
92. Oceanus Group Ltd, China
93. ONI Global Pte Ltd
94. Philips Electronics (S) Pte Ltd
95. Phoon Huat & Co Pte Ltd
96. Photocatalysis Industry Association of Japan
97. Quintech Life Science Pte Ltd
98. Resorts World at Sentosa Pte Ltd
99. Ross University School of Veterinary Medicine
100. Science Arts Co Pte Ltd
101. SCS Dairy
102. Sembcorp EOSM Pte Ltd
103. Shizuoka Prefectural Government of Japan
104. Shokuken Prefectural Government of Japan
105. Singapore Accreditation Council
106. Singapore General Hospital Pte Ltd
107. Singapore College of Traditional Chinese Medicine
108. Singapore Heart Foundation
109. Singapore Institute of Engineering Technologists
110. Singapore Nutrition and Dietetics Association
111. Singapore Peking Oxford Research Enterprise (SPORE), National University of Singapore
112. Singapore Police Force
113. Singapore Salads Pte Ltd
114. Singapore Sports Institute
115. Singapore Workforce Development Agency
116. Somnetics Global Pte Ltd
117. Soyjoy
118. Southern Taiwan University of Science and Technology
119. ST Kinetics Integrated Engineering Pte Ltd
120. Sunward Pharmaceutical Pte Ltd
121. Tai Tong Ah Co Pte Ltd
122. Temasek Foundation
123. Temasek Life Sciences Laboratory
124. The Mitolo Group
125. The National Centre for Genetic Engineering and Biotechnology, National Science and Technology Development Agency (BIOTEC)
126. Thermo Fisher Scientific
127. Tong Jum Chew
128. Transalgae Israel Ltd, Israel
129. Tung Lok Millenium
130. United BMEC Pte Ltd
131. Unicurd Food Company Pte Ltd
132. USA Poultry and Egg Export Council
133. University of Applied Sciences, Utrecht
134. Watsons Singapore
135. WEMMS Enterprise
136. Wenken Group
137. WhiteRock Medical Company Pte Ltd
138. Wildlife Reserves Singapore
139. Willowvale Asia Pte Ltd
140. Yaizu Suisankagaku Industry (YSK)
141. Yikowei Pte Ltd
142. Yi Shi Yuan Pte Ltd
143. Yun Onn Company Pte Ltd

LIST OF SPEAKERS AT ASC EVENTS

6 April 2010
SYMPOSIUM ON TRADITIONAL MEDICINE & LAUNCH OF CENTRE FOR TRADITIONAL MEDICINE

Mr Ted Tan
Deputy CEO
SPRING Singapore

Dr Allan Lim
Innovation Partnerships Manager
Nestlé R&D Centre (Pte) Ltd, Singapore

Ms Karol Tong
President
The Medicine Manufacturing Association of Singapore

Ms Samantha Su
Deputy Director, Services & Biomedical and International Partnership Office (Europe & Middle East) SPRING Singapore

20 November 2010
GI SYMPOSIUM: GLYCEMIC INDEX AT THE CROSSROADS - IMPLICATIONS FOR THE FOOD & HEALTHCARE INDUSTRIES

Prof Thomas Wolever
University of Toronto
President, Glycemic Index Laboratories, Inc., Canada

Dr Allan Lim
Innovation Partnerships Manager
Nestlé R&D Centre (Pte) Ltd, Singapore

Ms Chin Poh Yin
Head, Chemical & Biological and Certification, SAC Secretariat
SPRING Singapore

Dr Eric Khoo
Endocrinologist
National University Health System, Singapore

19 June 2012
NUTRITION SYMPOSIUM: INVESTING IN HEALTHIER FOOD & NUTRITION - NURTURING HEALTH

Dr Philip Chew Hong
Director, Technology & Industry Development
Agri-Food and Veterinary Authority of Singapore

Prof Thomas Wolever
University of Toronto
President, Glycemic Index Laboratories, Inc., Canada

Dr Amber Carla Bastian
Manager, Centre of Excellence (Nutrition)
Health Promotion Board

Mr Eddie Siow
Chief Executive Officer
IM Holdings Pte Ltd

Prof Jeya Henry
Director, Clinical Nutrition Sciences, SICS
*A*Star*

Chef Yen Koh
Executive Chef, Food Solutions
South East Asia, Unilever Asia Pte Ltd

28 Mar 2012
SCHOOL OF APPLIED SCIENCE SHOW 2012: TECHNOLOGY TRANSFER FOR COMMERCIAL SUCCESS: THE TP-INDUSTRY PARTNERSHIP

Mr Viktor Cheng
Deputy Director
Intellectual Property Office of Singapore

Dr Ardy Van Helvoort
Research and Development Director of Nutricia Medical Nutrition Asia
Danone Research – Centre for Specialised Nutrition, Singapore

Mr Culgan Soh
Senior Officer, Technology Innovation Department
SPRING Singapore

Mr David Lim
Chairman & CEO
Dawyn Impex Pte Ltd

Ms Dewi Hartaty Bte Suratty
Head, Halal Certification Strategic Unit
MUIS

23 JULY 2013
SCHOOL OF APPLIED SCIENCE SHOW: PARTNERS-IN-SCIENCE - ACHIEVING COMMERCIAL SUCCESS THROUGH BETTER QUALITY, SAFETY & EFFICACY

Mr Johnson Chen
Managing Partner
Clearbridge Accelerator Pte Ltd

Ms Alison Chen
Marketing Programme Manager, Services and Support Division
Agilent Technologies Singapore (Sales) Pte Ltd

Dr Ch'ng Ai Lee
Director, Veterinary Public Health Laboratory
Chemistry Department, Laboratories Group
Agri-Food and Veterinary Authority of Singapore

Prof Hanry Yu
Professor in Physiology
National University of Singapore

Mr Joe Fam
Executive Director
Wen Ken Marketing (S) Pte Ltd

1 OCTOBER 2014
SCHOOL OF APPLIED SCIENCE SHOW: INNOVATIVE SOLUTIONS FOR ENTERPRISE

Prof Thomas Wolever
University of Toronto
President, Glycemic Index Laboratories, Inc., Canada

Ms Anna Jacob
Director, Nutrition
Abbott Nutrition International

Dr Gan Chee Sian
Business Team Manager
Agilent Technologies Singapore (Sales) Pte Ltd

Mr Lim Meng Huat
Chief Operating Officer
APOLLO Aquarium Pte Ltd

Dr Lincoln Lim
Senior Lead in Product Research
Abbott Nutrition International

Dr Satya S. Jonnalagadda
Director, Global Nutrition
Kerry Ingredients & Flavours

Mr William Ling
Chief Executive Officer
Sembcorp EOSM Pte Ltd

8 – 9 OCT 2015
SCHOOL OF APPLIED SCIENCE SHOW & INSTITUTION OF AQUACULTURE SINGAPORE CONFERENCE: INNOVATIONS FOR SUSTAINABLE AQUACULTURE

Mr Desmond Lee
Senior Minister of State, Ministry of Home Affairs & Ministry of National Development

Dr Albert Tacon
Aquatic Farms Limited, USA

Dr Chang Siow Foong
MSD Animal Health Innovation Private Limited, Singapore

Dr Farshad Shishechian
President & CEO, Blue Aquaculture International
Founder & President of the Asian Aquaculture Network
President of the World Aquaculture Society, Asia Pacific Chapter

Dr Jesper Clausen
INVE Aquaculture Limited, Thailand

Dr Jiang Jun Hui
Senior Scientist
Agri-Food & Veterinary Authority of Singapore

Professor Jonathan Trent
OMEGA Global Initiative, USA

Dr Louis Landesman
Virginia State College of Agriculture, USA

Dr Ofra Chen
TransAlgae Israel Limited, Israel

Mr Romi Novriadi
Batam Mariculture Development Centre
Ministry of Marine Affairs and Fisheries, Indonesia

Mr Veerasun Prayotamornkul
Baxel Company Limited, Thailand

Professor Emeritus Dr Yoram Avnimelech
Israel Institute of Technology, Israel

LEADERSHIP@LUNCH

Ms Claire Chiang
Senior Vice-President
Banyan Tree Holdings

Mr Ho Kwon Ping
Founder & Executive Chairman
Banyan Tree Holdings

Mr Leslie Loh
Executive Chairman
Lithan Hall Academy

Dr N Varaprasad
Managing Partner
Singapore Education Consulting Group

SCHOOL ADVISORY COMMITTEE (SAC)

8TH SAC: 2015 - 2017

Chairman
Mr Andrew Tjioe
Founder & Executive Chairman, Tung Lok Group
President of the Restaurant Association of Singapore (RAS)

Deputy Chairman
Dr Lee Chee Wee
Director
School of Applied Science

Members
Dr Allan Lim
Group Manager
Nestlé R&D Centre (Pte) Ltd

Ms Ang Hui Gek
Director, Allied Health
Ministry of Health

Dr Annie Ling Mei Chuan
Director, Adult Health Division
Health Promotion Board

Mr Bernhard Schaufelberger
Regional Technical Director, Flavour Innovation Centre
Givaudan Singapore Pte Ltd

Ms Chang Kwei Fern
Director (Accreditation), SAC Secretariat
SPRING Singapore

Assoc Prof Elizabeth Ng Siew Kuan
Director of Intellectual Property Law, Centre for Law & Business
National University of Singapore

Ms Lee Choon-Siew
Audit Director, Supply Chain
GlaxoSmithKline Pte Ltd

Ms Low Min Yong
Assistant Group Director, Applied Sciences Group
Health Sciences Authority

Mr Lucas Ng Hong Kiang
General Manager (Plant)
Petrochemical Corporation of Singapore (Pte) Ltd

Ms Lynn Chua Shu Xian
Head, Consumer Businesses
Economic Development Board

Dr Manjeet Singh
Director
*Biopolis Shared Facilities (BSF) A*STAR*

Mr Mock Siew Fai
General Manager (Plant)
Mitsui Phenols (S) Pte Ltd

Dr Ng Lee Ching
Director, Environmental Health Institute
National Environment Agency

Assoc Prof Paul Heng Wan Sia
Department of Pharmacy
National University of Singapore

Mr Teng Chong Seng
Director, EHS
Pfizer Asia Pacific Pte Ltd

Assoc Prof Too Heng Phon
Department of Biochemistry
National University of Singapore

Dr Wong Hon Mun
Group Director, Agri Establishment Regulation Group
Agri-Food and Veterinary Authority of Singapore

7TH SAC: 2013 - 2015

Chairman
Mr Andrew Tjioe

Deputy Chairman
Dr Lee Chee Wee

Members
Ms Ang Hui Gek
Dr Annie Ling Mei Chuan
Mr Bernhard Schaufelberger
Ms Chang Kwei Fern
Mr Freddy Soon
Mr Gan Boon Teck
Ms Lee Choon-Siew
Mr Lucas Ng Hong Kiang
Ms Lynn Chua Shu Xian
Dr Ng Lee Ching
Assoc Prof Paul Heng Wan Sia
Dr Tan Hwa Luck
Mr Teng Chong Seng
Assoc Prof Too Heng Phon
Dr Wong Hon Mun

6TH SAC: 2011 - 2013

Chairman
Mr T K Udairam

Deputy Chairman
Dr Lee Chee Wee

Members
Ms Ang Hui Gek
Dr Annie Ling Mei Chuan
Mr Bernhard Schaufelberger
Mr Freddy Soon
Mr Gan Boon Teck
Mr Lucas Ng Hong Kiang
Dr Martin Lee
Dr Ng Lee Ching
Assoc Prof Paul Heng Wan Sia
Assoc Prof Shabbir M Moochhala
Ms Susanne Kulhanek
Dr Tan Hwa Luck
Mr Teng Chong Seng
Assoc Prof Too Heng Phon
Mr Vincent Hingot
Mr William Lim Tao-E
Dr Wong Hon Mun

5TH SAC: 2009 - 2011

Chairman
Mr T K Udairam

Deputy Chairman
Mrs Soon-Ong Meng Wan

Members
Ms Ang Hui Gek
Mr Ang Kiam Meng
Dr Annie Ling Mei Chuan
Ms Dawn Lee
Mr Freddy Soon
Ms Jocelyn Chng
Mr Kevin Harty
Assoc Prof Lee Chee Wee
Ms Lim Sze Ling
Mr Lucas Ng Hong Kiang
Dr Ngiam Tong Tau
Mr Vincent Hingot

4TH SAC: 2007 - 2009

Chairman
Mr T K Udairam

Deputy Chairman
Mrs Soon-Ong Meng Wan

Members
Ms Ang Hui Gek
Mr Beh Kian Teik
Ms Dawn Lee
Mr Freddy Soon
Ms Grace Seow
Ms Jocelyn Chng
Mr Kevin Harty
Assoc Prof Lee Chee Wee
Mr Lucas Ng Hong Kiang
Dr Ngiam Tong Tau
Mr Vincent Hingot

3RD SAC: 2005 – 2007

Chairman
Dr Loh Wah Sing

Deputy Chairman
Mrs Soon-Ong Meng Wan

Members
Ms Ang Hui Gek
Dr Annie Ling Mei Chuan
Dr Bryan E. Ogden
Mr Francis Goh Nyang Kuang
Assoc Prof Lee Chee Wee
Dr Loh Kean Chong
Mr Lucas Ng Hong Kian
Mr T K Udairam
Mr Yeoh Keat Chuan

2ND SAC: 2003 - 2004

Chairman
Dr Loh Wah Sing

Deputy Chairman
Mrs Soon-Ong Meng Wan

Members
Mr Abel Ang
Ms Ang Hui Gek
Dr Annie Ling
Mr Chua Song Khim
Mr Francis Goh
Assoc Prof Lee Chee Wee
Mr Leslie John Cheong
Dr Loh Kean Chong
Dr Pua Eng Chong
Dr Roberto Gardellin
Mr Tom Madilao

1ST SAC: 2001 - 2003

Chairman
Dr Loh Wah Sing

Deputy Chairman
Mrs Soon-Ong Meng Wan

Members
Ms Ang Hui Gek
Mr Chua Song Khim
Mr Francis Goh
Assoc Prof Lee Chee Wee
Mr Leslie John Cheong
Ms Loh Chin Siew
Assoc Prof Pua Eng Chong
Dr Roberto Gardellin
Mr Tom Madilao

Institutional Animal Care & Use Committee

Chairman
Dr Padmanabhan Saravanan

Advisor / Vice Chair
Dr Diana Chan

Secretary
Mr Joshua Desmond Chan Jit Han

In-House Veterinarian
Dr Jomer Bo Lucanas

Statistician
Mr Goh Miah Kiat

Scientific Personnel
Dr Lee Yun Hwa

Non-Affiliated Member
Ms Elisabeth Tan

Attending Veterinarians
Dr Koh Jun Jia
Dr Ng Cher Cheen

We would like to acknowledge the contribution of the following members:

Chairperson (2005-2013)
Dr Diana Chan

Non-Affiliated Member
Ms Chen Siew Peng

Secretary
Ms Viji Vijaykumarr

Attending Veterinarians
Dr Lim Ren
Dr Roshni Selvam
Dr Sim Kwang Poh

Scientific Personnel
Dr Jason Chang
Dr Lim Kah Meng

Institutional Review Board

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Mr Tan Guan Hwa
Administration

Mr Tan Keng Beng
Student Development

Ms Tan Lay Khee
Academic Development

**From February 2016*

List of Publications & Papers Presented at Conferences

Journal Publications

1. Beaumont C, Sackville A & Chew SC (2004). Identifying Good Practices in the Use of PBL to Teach Computing, ITALICS 3 (1), LTSN-ICS.

2. Bhaskaran K, Deurenberg P & Lim P (2003). Singaporean Chinese Adolescents Have More Subcutaneous Adipose Tissue than Dutch Caucasians of the Same Age and Body Mass Index. Asia Pacific Journal of Clinical Nutrition, 12(3), 261-265.

3. Caipang CMA, Choo HX, Bai Z, HuiLin H, Lay-Yag CM, Lim J (2015). Small-scale Production of Biofloc Using Various Carbon Sources for the Freshwater Culture of Tilapia. Oreochromis sp. ABAH Bioflux, 7 (1), 103-111.

4. Caipang CMA, Choo HX, Bai Z, Huang H, Lay-Yag CM (2015). Viability of Sweet Potato Flour as Carbon Source for the Production of Biofloc in Freshwater Culture of Tilapia. Oreochromis sp. International Aquatic Research, 7(4), 329-336.

5. Caipang CMA, Fagutao FF, Fatira E, Lazado CC, Pavlidis M (2015). Cortisol Levels and Expression of Selected Stress- and Apoptosis-related Genes in the Embryos of Atlantic Cod, Gadus Morhua Following Short-term Exposure to Air. International Aquatic Research, 7 (1), 75-84.

6. Chan GF (2014). Teaching and Learning Strategies Used in Metabolic Biochemistry to Stimulate Learning among Polytechnic Students. Scottish Journal of Arts, Social Sciences and Scientific Studies, 20(1), 55-69.

7. Chew LL (2014). A Curriculum Redesign for Enhanced Student Engagement and Meaningful Learning. The International Journal of Pedagogy and Curriculum, 22(12), 1-13.

8. Choo HX, Caipang CMA (2015). Biofloc Technology (BFT) and Its Application Towards Improved Production in Freshwater Tilapia Culture. AACL Bioflux 8, 362-366.

9. Huang Z, Ong SL & Ng HY (2013). Effect of Solids Retention Time on Submerged Anaerobic Membrane Bioreactor for Domestic Wastewater Treatment. J Biotechnol, 164(1), 82-90. doi: 10.1016/j.jbiotec.2013.01.001

10. Lazado CC, Caipang CMA, Estante EG (2015). Prospects of Host-associated Microorganisms in Fish and Penaeids as Probiotics with Immunomodulatory Functions. Fish & Shellfish Immunology, 45 (1), 2-12.

11. Lei S & Fu Y (2011). Isolation, Purification, and Immunomodulatory Activity in Vitro of Three Polysaccharides from Roots of Cudrania tricuspidata. Acta Biochimica et Biophysica Sinica, 43(5), 418-424. doi: 10.1093/abbs/gmr024.

12. Li H, Yang H, Xue X, Tian F, Liu X, Poh Y, Cai H, Lee YH, Yu H, Ong SP, & Cai BC (2016). A Metabolomics Approach to Study the Dual Modulation by Characterisation of Chemical Alteration during Processing of Gardeniae Fructus Using UPLC-ESI-QTOF. Analytical Methods. doi: 10.1039/c5ay03265b.

13. Li L, Koo SH, Limenta LM, Han L, Hashim KB, Quek HH & Lee EJ (2009). Effect of Dietary Purines on the Pharmacokinetics of Orally Administered Ribavirin. Journal of Clinical Pharmacology, 49(6), 661-7. doi: 10.1177/0091270009335002.

14. Ma NKL, Lim JK, Leong MF, Sandanaraj E, Ang BT, Tang C & Wan ACA (2016). Collaboration of 3D Context and Extracellular Matrix in the Development of Glioma Stemness in a 3D Model. Biomaterials, 78, 62–73.

15. Ouvry-Patat AS, Torres MP, Quek HH, Gelfand CA, O'Mullan P, Nissum M & Borchers CH (2008). Free-flow Electrophoresis for Topdown Proteomics by Fourier Transform Ion Cyclotron Resonance Mass Spectrometry. Proteomics, 8(14). 2798-808. doi: 10.1002/pmic.200800079.

16. Pang E, Tien-Lin C, Selvaraj M, Chang J & Kwang J (2011). Deletion of the aceE Gene (Encoding a Component of Pyruvate Dehydrogenase) Attenuates Salmonella Enterica Serovar Enteritidis. FEMS Immunol Med Microbiol, 63(1), 108-18. doi: 10.1111/j.1574-695X.2011.00834.x.

17. Peng Y, Gelder VV, Anburaj A & Haribhai PK (2016). Covalent Binding of Antibodies to Cellulose Paper Discs and Their Applications in Naked-Eye Colorimetric Immunoassays. Journal of Visualised Experiments (in press).

18. Png W, Bhaskaran K, Sinclair AJ, Aziz AR (2014). Effects of Ingesting Low Glycemic Index Carbohydrate Food for the Sahur Meal on Subjective, Metabolic and Physiological Responses, and Endurance Performance in Ramadan Fasted Men. International Journal of Food Sciences and Nutrition, 65 (5), 629-636.

19. Safari R, Adel M, Lazado CC, Caipang CMA, Dadar (2016). Host-Derived Probiotics Enterococcus Casseliflavus Improves Resistance Against Streptococcus Iniae Infection in Rainbow Trout (Oncorhynchus Mykiss) via Immunomodulation. Fish & Shellfish Immunology, 52, 198-205.

20. Wan ACA, Cutiongco MFA, Tai BCU, Leong MF, Lu HF & Yim EKF (2016). Fibres by Interfacial Polyelectrolyte Complexation – Processes, Materials and Applications. Materials Today, http://dx.doi.org/10.1016/j.mattod.2016.01.017.

21. Wolever TMS & Bhaskaran K (2012). Use of Glycemic Index to Estimate Mixed-Meal Glycemic Response. The American Journal of Clinical Nutrition, 95(1), 256-257. doi:10.3945/ajcn.111.026880.

22. Wong SF & Ting SK (2009). Use of Recycled Rubber Tyres in Normal- and High-Strength Concretes. ACI Materials Journal, 106(4), 325-332.

23. Wong SF, Ting SK, Lin M, Shamini M & Tay BK (2015). Novel Geopolymers Incorporating Wollastonite and Recycled Plastics. Advanced Materials Research, 1129, 39-48.

24. Wuang SC, Khin MC, Chua D & Luo D (2016). Use of Spirulina Biomass Produced from Treatment of Aquaculture Wastewater as Agricultural Fertilisers. Algal Research, 15, 59–64.

25. Wuang SC, Luo D, Wang S, Chua D & Tee PS (2016). Performance Assessment of Biofuel Production in an Algae-Based Remediation System. Journal of Biotechnology, 221, 43–48.

26. Yarahmadi P, Miandare HK, Fayaz S, Caipang CMA (2016). Increased Stocking Density Causes Changes in Expression of Selected Stress- and Immune-related Genes, Humoral Innate Immune Parameters and Stress Responses of Rainbow Trout (Oncorhynchus Mykiss). Fish & Shellfish Immunology, 48, 43-53.

Magazine Articles

1. Caipang CMA & Maningas MB (2015). Molecular Diagnostics for Pathogenic Diseases in Aquaculture. INFOFISH International 3, 40-42.

2. Caipang CMA (2015). DNA Barcoding for Food Safety of Aquatic Products. INFOFISH International 5, 53-55.

Books

1. Cai B, Ong SP & Liu X (2012). High Performance Liquid Chromatography Fingerprinting Technology of the Commonly-used Traditional Chinese Medicine Herbs. Singapore: World Scientific Publishing C. Pte. Ltd. [Translated by Zhang P & Li H]

2. Chan GF & Zhang P (2015). "THE" Metabolic Biochemistry. Singapore: McGraw-Hill Education.

3. Chew SC & Beaumont C (2006). How Do Participants Use Different Mediation Tools in Problem-based Learning Online? In Savin-Baden, M. (ed). PBLOnline. McGraw Hill.

4. Krishnasamy S & Chan JD (2013). Communication Skills for Applied Science (Level 1). Singapore: McGraw-Hill Education Asia.

5. Krishnasamy S & Chan JD (2015). Effective Communication. Singapore: McGraw-Hill Education.

6. Lai ZS, Lim JX, Li B & Chew SC (2015). Mathematics for Applied Science. Singapore: McGraw-Hill Education Asia.

7. Lei S (2011). Inorganic and Analytical Chemistry. Wuhan: Huazhong University of Science & Technology Press.

8. Lim P (2009). (Chapter) In Living S.M.A.R.T. – A Lower Secondary Course in Home Economics, Book 1 Normal (Technical). Singapore: Pearson Education South Asia Pte Ltd.

9. Rajaseger G & Saravanan P (2014). Toxins of GID Relevance. In Textbook of Toxicology Biological Toxins and Terrorism. New York: Springer Publications.

10. Saravanan P, Rajaseger G & Eric YP (2014). Botulinum Neurotoxins – A Review. In Textbook of Toxicology – Biological Toxins and Terrorism. New York: Springer Publications.

11. Tan HM, Li B, Lai ZS, Yang HB & Chew SC (2013). Mathematics and Statistics 2. Singapore: McGraw-Hill Education Asia.

12. Tan HM, Li B, Lai ZS & Chew SC (2014). Mathematics and Statistics 1. Singapore: McGraw-Hill Education Asia.

13. Temasek Polytechnic BCS ASC. (2015). Singapore Hawker Classics Unveiled: Decoding 25 Favourite Dishes. Singapore: Marshall Cavendish.

14. Vijaykumarr V & Lee PLJ (2015). Scientific Communication (Asian customised ed.). Singapore: McGraw-Hill Education (Asia).

15. Wong SF (Editor-in-Chief), Tan KH & Ong KCG (2015). Polymers in Concrete – Towards Innovation, Productivity and Sustainability in the Built Environment. Advanced Materials Research, 1129. Selected, peer reviewed papers from the 15th International Congress on Polymers in Concrete (ICPIC 2015). Singapore.

Papers / Posters Presented at Conferences

1. Beaumont C & Chew SC (2003). PBL Sans Frontiers: Using ICT to Facilitate Learning in Globally Distributed Teams. Presented at the Enquiry-Based Learning Conference, University of Manchester, UK.

2. Bhaskaran K, Hsu FH, Sijben J, Hussain SS & Helvoort AV (2014). Souvenaid, a Medical Food with a Low Glycemic Index for Alzheimer's Patients. Presented at the Alzheimer's Association International Conference (AAIC), Copenhagen.

3. Bhaskaran K, Hussain SS, Toh V, Khalilah N, Humaira S, Raihana & Ong JT (2014). Determination of Glycemic Index of Mixed Meals and Dietary Glycemic Load of Selected Females. Presented at the Asian Congress of Dietetics, Taipeh.

4. Bhaskaran K, Hussain SS & Yap WQ (2013). Glycemic Index Determination of Rice Varieties and Its Association with Amylose and Amylopectin Content. Presented at the 13th ASEAN Food Conference, Singapore.

5. Bhaskaran K, Chen R & Lau KY (2009). Analysis of Glycemic Index of Muffins among Healthy Subjects and Type 2 (Non-Insulin Requiring) Diabetics. Presented at the NHG Scientific Congress, Singapore.

6. Bhaskaran K & Ho TF (2009). Prevalence of Eating Disorders in Young Singaporean Females and Their Dietary Practices. Presented at the 19th International Congress of Nutrition, Bangkok.

7. Bhaskaran K & Lau KY (2009). Development of Shelf Stable Low Glycemic Index Quick Bread. Presented at the American Overseas Dietetics Association Conference, Kuala Lumpur.

8. Bhaskaran K & Lau KY (2008). Development of White Bread with Low Glycemic Index Ingredients. Presented at the Swiss Singapore Workshop on Innovation in Food-Consumer Interactions, Singapore.

9. Bhaskaran K, Lee XYC, Irhamna MT, Wong H & Deurenberg P (2003). Dietary Intake and Physical Activity of Singaporean Adolescents. Presented at the 2nd Asian-Oceania Conference of Obesity (MASO 2003), Kuala Lumpur.

10. Bhaskaran K, Choo YS & Deurenberg P (2001). Relative Validity of Skinfold Thickness Measurement and Hand-Held Bioelectrical Impedance for the Assessment of Body Fat in Singapore Adolescents. Presented at the 4th MASO Conference on Obesity, Kuala Lumpur.

11. Bhaskaran K, Tan VMH, Ong F, Tan YL, Venkataraman K, Mann J, Lee KO, Tai ES, Lee YS & Khoo YH. Ethnic Differences in Dietary Glycemic Measures of Individuals with Type 2 Diabetes Mellitus in Singapore. Presented at the International Congress of Dietetics, Sydney.

12. Chan JD (2013). Online or Face-to-Face Communication Skills Module? An Investigation of Learners' Perceptions. Presented at the National University of Singapore Centre for English Language & Communication 2013 Symposium, Singapore.

13. Chew LL (2014). A Curriculum Redesign for Enhanced Student Engagement and Meaningful Learning. Presented at the 21st International Conference on Learning, New York.

14. Chew SC, Chew LL, Li B, Lai ZS, Lim JX & Hei JJ (2015). Paving the Way for Inquiry-Based Learning: Developing Essential Skills for the Curious Student. Presented at the Rethinking Teaching, Redesigning Learning Conference, Temasek Polytechnic, Singapore.

15. Chew SC, Chew LL, Li B, Lai ZS, Lim JX & Hei JJ (2015). Creating an Effective Environment for Inquiry-based Elearning in Science Education. Presented at the Redesigning Pedagogy International Conference 2015, NIE, Singapore.

16. Chew SC, Li B, Lai ZS, & Lim JX (2014). Enabling Effective E-learning: Making It Simple. Presented at the Learning Academy Conference, Temasek Polytechnic, Singapore

17. Chew SC (2011). Applied Science Bridging Programme. Presented at the Learning Academy Conference, Temasek Polytechnic, Singapore.

18. Chew SC, Tay L & Zhou L (2010). Digital Literacy Workshop for Freshmen. Presented at the Temasek Polytechnic International Conference on Teaching and Learning, Singapore.

19. Chew SC & Beaumont C (2004). Evaluating the Effectiveness of ICT to Support Globally Distributed PBL Teams. Proceedings of ITiCSE Conference, Leeds, ACM/SIGCSE 47-51.

20. Chew SC & Beaumont C (2004). Supporting Globally Distributed PBL Teams Using a Rich ICT Environment: How Do Participants Use Different Mediation Tools? Proceedings of the 4th International Networked Learning Conference, Lancaster, 380-387.

21. Chew SC (2000). Preparing Students and Faculty for Educational Change: Examples from the School of IT & Applied Science. Presented at the 2nd Asia Pacific Conference on PBL.

22. Chooi KF, Phang SSG, Toh HHA & Kuppan RDB (2014). Additional Use of the Rat Model to Study Liver Cirrhosis Regression. Presented at the 65th Association of American Laboratory Animal Science Meeting, San Antonio.

23. Chooi KF (2012). Modelling Liver Fibrosis in the Rat. Presented at the 4th National Conference on Laboratory Animal Science, Kuala Lumpur.

24. Chooi KF, Phang SSG, Toh HHA, Rashidah S, Tai D & Yu H (2012). Assessment of Liver Fibrosis in the Rat. Presented at the 63rd Association of American Laboratory Animal Science Meeting, Minneapolis.

25. Chooi KF (2011). Modulating Liver Fibrosis in Wistar Rats with Dosage of DMN. Presented at the 7th Singapore Association for Laboratory Animal Science Meeting, Singapore.

26. Chooi KF (2010). Current Status of Laboratory Animal Science in Singapore. Presented at the 4th AFLAS Congress, 5th AMMRA Meeting & 11th CSLAS Annual Meeting, Taipei.

27. Easwaran P, Bhaskaran K (1997). Therapeutic Uses of Selected Under-exploited Foods. Presented at the 16th International Congress of Nutrition, Montreal.

28. Goh K, Vijayan N, Loh GH, Chan SM & Tang MF (2013). Critical Success Factors and Challenges in Developing Student Self-assessment Skills at Temasek Polytechnic. Presented at the Joint SELF Biennial International Conference and ERAS Conference, Singapore.

29. Ho TF & Bhaskaran K (2007). Dietary and Nutrition Profile of Young Females at Risk of Or Diagnosed with Eating Disorders. Presented at the Obesity Conference, Oslo.

30. Hogan AG, Nur Aishah A, Ng ZY, Phang SSG, Kuppan RDB & Chooi KF (2015). The Use of Grimace Scale as a Regular Component of Pain Assessment in Liver Fibrosis Studies. Presented at the SALAS-AAALAC Annual Regional Conference, Singapore.

31. Hor M, Vijayan N & Goh K (2013). Improving Students' Reflective Capability Through Self-Assessment in a Tutorial Setting. Presented at the Joint SELF Biennial International Conference and ERAS Conference, Singapore.

32. Joseph A, Easwaran P & Bhaskaran K (1994). Glycemic Index of Selected Breakfast Items. Presented at the 27th Annual Conference of Indian Dietetic Association, Chandigarh.

33. Kuppan RDB, Phang SSG, Toh HHA & Chooi KF (2014). Quantification of Collagen Deposit in Liver Fibrosis Using Cellprofiler. Presented at the 18th Federation of Asian Veterinary Associations (FAVA) Congress, Singapore.

34. Kuppan RDB, Phang SSG, Toh HHA & Chooi KF (2012). Computational Approach to Quantifying Collagen Deposit in Liver Fibrosis. Presented at the 8th Singapore Association for Laboratory Animal Science Meeting, Singapore.

35. Lee LJ (2014). A Transcriptomic Examination of Sexual Differentiation in Zebrafish. Presented at the Plant and Animal Genome Asia 2014 Conference, Singapore.

36. Lim YL (2008). Proteomic Analysis of Secretory, Cell Surface & Periplasmic Proteins from the Gram-Negative Nosocomial Pathogen Stenotrophomonas maltophilia. Presented at the Joint 5th Structure Biology and Functional Genomics and 1st Biological Physics International Conference, Singapore.

37. Lim YL (2008). Proteomic Analysis of Secretory, Cell Surface & Periplasmic Proteins from the Gram-Negative Nosocomial Pathogen Stenotrophomonas maltophilia. Presented at the 8th National Healthcare Group Annual Scientific Conference, Singapore.

38. Lim YL, Lee QH, Ch'ng JY, Teo XQ, Ge XW, Zeng Y & Quek HH (2012). Identification of Signature Peptides for the Authentication of cornu Saiga tartarica. Presented at the 6th AOHUPO Congress 2012, China.

39. Loh GH, Choondee E, Tan A, Vijayan N & Goh K (2013). An Investigation of Students' Transfer of Self-assessment Process in Two Subjects. Presented at the Joint SELF Biennial International Conference and ERAS Conference, Singapore.

40. Loh GH, Kho CJ & Lee CW (2013). Developing Student Self-assessment Skills at Temasek Polytechnic. Presented at the Joint SELF Biennial International Conference and ERAS Conference, Singapore.

41. Loh GH, Vijayakumari S, Tay SC, Lim P & Soon MW (2010). Learning Enterprises in Temasek Polytechnic School of Applied Science. Presented at the Temasek Polytechnic International Conference on Teaching and Learning, Singapore.

42. Loh GH, Zhang PC, Tan LK & Goh MK (2015). Assessment for Learning in School of Applied Science. Presented at the Temasek Polytechnic International Conference on Teaching and Learning, Singapore.

43. Miao H, Nadarajan R, Loke MF, Lee A, Tay BK & Xu Y (2012). Genetic Engineering of Clostridium Beijerinckii Strain for Improved Butanol Production from Xylose. Presented at the 62nd Annual Meeting of the Society for Industrial Microbiology and Biotechnology, USA.

44. Nur Aishah A, Hogan AG, Ng ZY, Phang SSG, Kuppan RDB & Chooi KF (2015). Refinement of Restraint for Intraperitoneal Injection in Male Rats. Presented at the SALAS-AAALAC Annual Regional Conference, Singapore.

45. Ogawa C, Lucanas J, Chan D & Chooi KF (2009). A Study on the Use of a Novel Biosensor in Monitoring Microenvironmental Parameters for Laboratory Rodent Cages. Presented at the 5th SALAS Regional Annual Conference, Singapore.

46. Phang SSG, Toh HHA, Kuppan RDB & Chooi KF (2013). Physical Assessment of Facial Expressions Using the Modified Rat Grimace Scale to Evaluate Pain. Presented at the 9th Singapore Association for Laboratory Animal Science Meeting, Singapore.

47. Sim L (2013). An Intervention Tool for Solving Calculation-Based Problems in a Chemical Engineering Subject Using the DEV-SOLVE Model. Presented at the Joint SELF Biennial International Conference and ERAS Conference, Singapore.

48. Tan LK, Goh KHB & Vijayan N (2014). Student Self-assessment to Enhance Learning in Pharmacotherapeutics. Presented at the Higher Education Research and Development Society of Australasia (HERDSA) 2014 Conference, Hong Kong.

49. Tan LK (2015). Self-assessment in a PBL Subject: Exploring Students' Motivation, Task Value Beliefs and Metacognitive Self-regulation. Presented at the 4th International Problem-based Learning Symposium, Singapore.

50. Toh HHA, Kuppan RDB, Phang SSG & Chooi KF (2012). Effect of DMN on Haematological Parameters during Progression of Liver Disease in the Rat. Presented at the 8th Singapore Association for Laboratory Animal Science Meeting, Singapore.

51. Vijaykumarr V, Lee PLJ & Chee WHJ (2015). Investigating the Use of Feedback and Scaffolding Mechanisms in an Online Platform. Presented at the Temasek Polytechnic International Conference on Teaching and Learning, Singapore.

52. Wong SF (2015). Use of Recycled Plastics in Building Materials. Presented at the BCA-RMCAS Seminar on Sustainable Concrete, Singapore.

53. Wong SF, Lin M, Tay BK, Ting SK & Ghosh S (2013). Novel Geopolymers Incorporating Recycled Materials. Presented at the 38th International Conference on Our World in Concrete & Structures, Singapore.

54. Wong SM, Tan SJX, Koh J, Zainul M, Phang SSG, Toh HHA, Kuppan RDB & Chooi KF (2013). The Rat Face Finder and Improved Assessment of Visceral Pain. Presented at the 9th Singapore Association for Laboratory Animal Science Meeting, Singapore.

55. Wong SF, Zhao X, Tay BK, Ghosh S & Ting SK (2012). Development of a Permeable Interlocking Pavement System Using Recycled Plastics. Presented at the 37th International Conference on Our World in Concrete & Structures, Singapore.

56. Wong SF (2010). Use of Recycled Plastics in a Pavement System. Presented at the 35th International Conference on Our World in Concrete & Structures, Singapore.

57. Zhang PC, Tan KB, Loh GH, Goh KHB & Vijayan N (2013). Self and Peer Assessment in Laboratory Skills. Presented at the Joint SELF Biennial International Conference and ERAS Conference, Singapore.

58. Zhang PC, Tan KB, Lee YH, Haribhai PK, Choondee E, Loh GH, Vijayan N & Goh K (2013). Developing Students' Self-Assessment Skill within Two Laboratory Skills Subjects. Presented at the Joint SELF Biennial International Conference and ERAS Conference, Singapore.

59. Zhao X, Wong SF, Tay BK, Ting SK & Ghosh S (2012). Chemically Bonded Composites Incorporating Cementitious Fillers and Recycled Plastics. Presented at the International Conference on Engineering & Applied Science, Beijing.

Testimonials

Singapore Accreditation Council (SAC), under the aegis of SPRING Singapore, is a long-standing partner of ASC. Together, we have achieved many successes, including providing greater assurance of functional food testing such as glycemic index (GI), and building competencies in analytical instrumentation and laboratory management with ASC staff attachments to SPRING to be trained as Lead Assessors for laboratory accreditation. We are also addressing the educational and training needs of current and prospective employees of laboratories in Singapore through the joint development and conduct of the *Specialist Diploma in Laboratory Management and Instrumentation*. Through such collaborations, we hope to raise the quality and standard of practices in the testing industry. Furthermore, being part of the School Advisory Committee gives SAC the opportunity to share our experiences as well as industry trends. I believe this 'win-win' partnership has had a positive impact on the industry.

Ms Chang Kwei Fern
Director, Accreditation
SAC Secretariat
SPRING Singapore

ASC is a school of excellence in chemical, biological and food sciences and is instrumental in moulding the professionals, experts and leaders of tomorrow. I am proud to be associated with the school's academic advisory committee and to contribute to its continued success.

Mr Lucas Ng Hong Kiang
General Manager (Plant)
Petrochemical Corporation of Singapore Pte Ltd

I am truly amazed at the programmes and initiatives the school constantly undertakes to remain industry-relevant and successful in our fast-changing world. The calibre of students joining the workforce, and innovative spirit they bring with them, are key assets to any future employer and create many opportunities for a successful career.

Mr Bernhard Schaufelberger
Regional Technical Director
Flavour Innovation Centre
Givaudan Singapore Pte Ltd

ASC is a progressive school of learning, quickly adapting and proactively addressing the constantly changing needs of the country. I am glad to say that the vision of continually aspiring to be better than it is today is encouraging. The commitment of the staff and the leadership to venture into unfamiliar areas, beyond their comfort zone, will invariably inculcate an entrepreneurial spirit that challenges stale norms. The continued dedication in the pursuit of excellence will pave a bright future for ASC.

Assoc Prof Too Heng Phon
Department of Biochemistry
National University of Singapore

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Survival requires you to change. If you don’t change, then you’re marginalised and you will become extinct.

Lee Kuan Yew
1st Prime Minister of Singapore
(from CNN interview with Fareed Zakaria, 2008)

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