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Singapore — The Biopolis of Asia

Where talent fuels science
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Singapore: Your Essential Partner in Asia

The global biomedical sciences industry is confronted with the need to improve R&D productivity and address unmet healthcare needs in fast-growing regions such as Asia. At the same time, companies need to navigate Asia's complexities and diversity to effectively tap into the region's fast-growing markets. As Asia's leading bio-cluster, Singapore is well-positioned to help biomedical sciences companies accelerate their innovation and capitalise on Asia's growth story.

Singapore has established a strong track record as a global manufacturing site in Asia. Today, leading pharmaceutical, biotechnology and medical technology companies have invested in more than 50 commercial-scale facilities, and continue to partner Singapore in enhancing manufacturing excellence in areas such as sustainable manufacturing, process development as well as upgrading suppliers' capabilities to address niche requirements.

Singapore presents key advantages for companies that seek to improve R&D productivity and develop innovative medical devices for Asia. Biomedical sciences companies can tap into the multidisciplinary capabilities offered by Singapore's integrated research network in basic and translational research. Today, 4,300 researchers carry out biomedical sciences R&D in more than 50 companies and 30 public-sector institutes, with more than S\$1 billion dedicated to R&D annually.

As companies seek to expand their footprint in Asia to tap into the region's fast-growing healthcare markets, Singapore has emerged as a key beach-head site for both global companies and Asian enterprises. Leading companies, including 8 of the top 10 pharmaceutical and all of the top 10 medical technology companies, have established their regional headquarters in Singapore to drive their business expansion and innovation in Asia.

Since the year 2000, when Singapore launched its biomedical sciences initiative, the Singapore Economic Development Board (EDB) has worked closely with other public-sector agencies, such as the Agency for Science, Technology and Research (A*STAR), the Ministry of Health (MOH), and our universities, to build up scientific and clinical excellence, which is essential in fueling the growth of our biomedical sciences sector.

Singapore's vision is to be the Biopolis of Asia, a leading international biomedical sciences cluster advancing human health by achieving excellence across the entire value chain. The Government has invested in more than S\$5 billion in building up industrial, human and intellectual capital, and remains fully committed to developing this sector.



Beh Kian Teik

Director
Biomedical Sciences
Singapore Economic
Development Board

More than 2,000 researchers carry out biomedical R&D in Biopolis, an integrated research campus that co-locates biomedical public-sector research institutes with corporate labs. Biopolis is located next to a key academic medical centre (Kent Ridge Campus), and to Fusionopolis where public-sector institutes in physical sciences and engineering are located. The proximity to these key components of Singapore's research infrastructure facilitates translational research and medical technology innovation.

Drug Discovery & Development

At a time when companies are grappling with declining R&D productivity, Singapore's integrated research network enables companies to access multidisciplinary capabilities in a single location, thereby improving R&D decision-making and accelerating drug discovery and development.

Excellence in discovery science

Singapore has an established research community that includes seven A*STAR public-sector biomedical research institutes, six disease/technology platform-focused consortiums, two leading universities and two academic medical campuses. Singapore's intellectual output has ranged from publications in high-impact journals and approved and filed patents, to partnerships with industry players and spin-off companies. As of 2008, A*STAR had achieved more than 1,900 publications in biomedical journals.

A*STAR research highlights can be accessed at www.research.a-star.edu.sg

Key capabilities in discovery science include:

- Cancer genetics
- Epigenetics, genome-wide association studies
- Computational biology
- Systems immunology
- Stem cells for assays & therapy
- Pre-clinical to clinical imaging
- Biomarker discovery
- Animal model development
- Biologics process optimisation
- Bioengineering & nanotechnology

Access to scientific talent

Singapore's exciting research environment, high quality of life and open immigration policies have been a draw for global and regional talent. Today, more than 4,300 researchers carry out biomedical sciences R&D, and companies can tap the annual pool of more than 8,500 science and engineering graduates from local universities.

Biopolis: Plug-and-play infrastructure

This 2.8 million square-foot research campus co-locates public- and private-sector labs and allows them to rapidly establish operations with minimal up-front capital outlay. Scientists and researchers can tap onto shared services ranging from basic glassware washing to high-end scientific services such as confocal microscopy, mass spectrometry and customised proteomics. Companies can also access cutting-edge scientific research equipment and Specific Pathogen Free containment facilities.

Discovery science at a glance

For the year 2008,

- GERD: 2.8% of GDP
- 103 researchers per 10,000 labour force
- 1,581 patents applied; 730 patents awarded
- A*STAR's research units are staffed by 2,620 researchers
- Tertiary institutes (including National University of Singapore, Nanyang Technological University, Duke-NUS Graduate Medical School Singapore) were staffed by 5,511 researchers
- 1.41 papers published per 1,000 people (Wiley-Blackwell, 2007)
- World's no. 1 in intellectual property protection (WEF Global Competitiveness Report, 2009-2010)

Public-Private Partnerships

Leading pharmaceutical companies are co-located with A*STAR research institutes at the Biopolis, and engage in regular public-private partnerships. In recent years, the growing base of biotech companies in Singapore have also tapped onto this integrated research network to accelerate drug discovery and development. Recent announcements include:

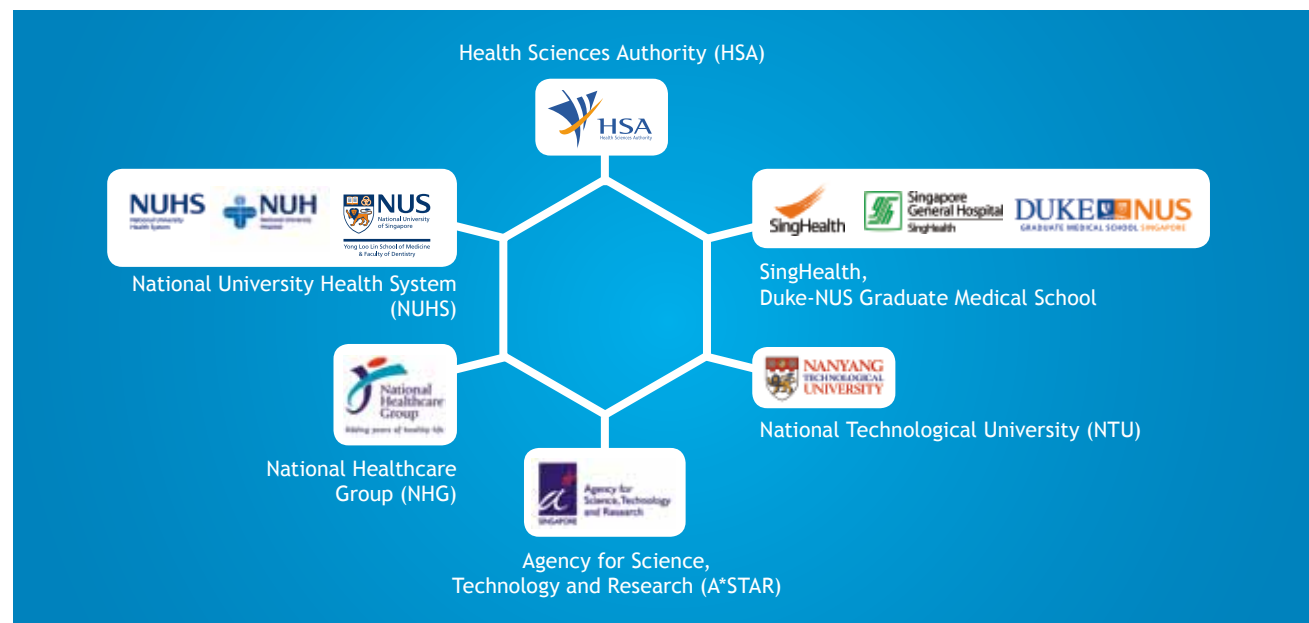
- Humalys SAS and Cytos Biotechnology are working with the Singapore Immunology Network to develop antibody-based therapies for infectious diseases that are prevalent in Asia.
- Siena Biotech is partnering A*STAR's Experimental Therapeutics Centre to develop molecular inhibitors of a major signalling pathway in oncology to target difficult-to-treat forms of cancer such as gastric cancer, leukaemia and brain tumours.

Companies with R&D bases in Singapore include

- Abbott – stability studies on API and novel formulations
- CellResearch Corp – stem cell research
- GlaxoSmithKline – neurodegenerative diseases research
- Inviragen – vaccine development for infectious diseases
- MerLion Pharma – natural product research
- Novartis – dengue fever, tuberculosis and malaria research
- PharmaLogicals – biomarker discovery, cancer research
- Merck Sharp & Dohme – biomarker discovery, non-invasive imaging
- S*Bio – drug development for oncology
- Takeda – target validation and pharmacology



Global scientific leaders who are heading Singapore's research institutes at the Biopolis include Prof Edward Holmes, Executive Chairman, National Medical Research Council and Deputy Chairman, Biomedical Sciences Research Council, A*STAR (centre); Prof Edison Liu, Executive Director, Genome Institute of Singapore, A*STAR (right); and Prof Jackie Ying, Executive Director, Institute of Bioengineering and Nanotechnology, A*STAR (left).



Singapore's integrated research network provides easy access to multidisciplinary capabilities and facilitates coordination amongst partners—all in one location.

Facilitating translational and clinical research

The tight linkages amongst Singapore's 30 research and medical institutes have created an ecosystem where research data and information can be efficiently generated, shared and analysed between clinical and discovery science teams. This integrated network further facilitates pharmacovigilance, healthcare outcomes and data monitoring.

In addition, Singapore's location in the heart of Asia and its pan-Asian population make the city-state a natural location to carry out studies and evaluate ethnic differences (between Chinese, Malays and Indians) in diseases that have a distinct Asian phenotype. Data gleaned from these research efforts can be used to pinpoint new targets relevant to global markets, while developing future therapies customised for Asian patients.

In 2006, Singapore introduced the Translational & Clinical Research (TCR) Flagship Programme, which presents a platform for researchers and clinician-scientists to collaborate in solving scientific problems and translate their research into quality healthcare solutions for patients. Five TCR flagship programmes with a five-year budget of S\$25 million each have been launched; they focus on five key disease areas where Singapore has unique strengths and healthcare relevance: cancer, eye diseases, neuroscience, metabolic diseases and infectious diseases.

Cutting-edge capabilities and infrastructure

Singapore has established cutting-edge capabilities and infrastructure to handle complex bench-to-bed and bed-to-bench translational and clinical research projects. This helps companies to move

promising candidates more rapidly to the proof-of-concept stage.

These core resources include:

- Dedicated clinical bio-imaging research and early-stage research trial facilities
- Platform technologies in genomics and bio-imaging
- Capabilities in creating unique pre-clinical predictive disease models

Growing base of clinician scientists

Singapore has built up a core of clinician scientists through initiatives such as the Singapore Translational Research (STaR) Investigator Award, which is designed to recruit and nurture world-class clinician scientists to undertake translational and clinical research in Singapore, as well as the Clinician Scientist Award (CSA), which provides research funding and salary support to enable medical researchers to devote more time to research.

At the institutional level, the National University of Singapore (NUS) has partnered Duke University to establish the Duke-NUS Graduate Medical School, Singapore's first graduate medical school. In 2010, Harvard's Beth Israel Deaconess Medical Center announced its collaboration with NUHS in education, research and clinical care. In addition, Singapore is investing in integrated facilities that will house research, education and training in one location. They include the Centre for Translational Medicine at NUHS and the new Khoo Teck Puat Building at the SGH Campus, where Duke-NUS Graduate Medical School Singapore is co-located with the Singapore General Hospital.

Pro-innovation environment

Singapore seeks to provide a regulatory framework that facilitates the development of innovative therapies, while ensuring global standards of safety, quality and efficacy. The Singapore's Health Sciences Authority (HSA) is actively involved in defining new regulatory frameworks and pursuing new areas of research in regulatory science. HSA hosted the 3rd Summit of Heads of Medicines Regulatory Agencies in December 2008 and will co-host the 14th International Conference of Drug Regulatory Authorities with World Health Organisation (WHO) in November/December 2010.

HSA has also forged MOUs with world's leading regulatory agencies such as the U.S. Food and Drug Administration, China's State Food and Drug Administration and UK's Medicines and Healthcare Products Regulatory Agency. In October 2009, Singapore was accepted into OECD's Mutual Acceptance of Data framework that enables data from GLP-compliant preclinical trials conducted in Singapore to be accepted by 30 OECD and non-OECD members that include the U.S., EU and Japan.

Managing clinical research across Asia

Companies can tap into Singapore's growing base of discovery, niche and clinical CROs to facilitate their drug discovery activities. Today, Singapore has established a core base of leading CROs (e.g. Quintiles, Covance, PPD, ICON) that manage regional clinical trials from the city-state. These international CROs offer a wide range of services, ranging from Phase I to pharmacovigilance studies. Some are also setting up innovative biomarker discovery and validation services to support their clients. Besides CROs, companies can also tap on Singapore Clinical Research Institute's capabilities in biostatistics, epidemiology, study design and evidence synthesis as well as full study execution in single and multi-centre studies from proof-of-concept to Phase 4 studies. SCRI is also engaged in implementing clinical research networks across Singapore and in the Asia-Pacific region.

Companies that have set up translational labs include:

- PharmaLogicals – biomarker discovery and cancer research
- Takeda – pre-clinical disease model development

Companies/resources supporting translational research include:

- Investigational Medicine Units at National University Health System, SGH Campus, Changi General Hospital, Institute of Mental Health, National Neuroscience Institute
- SingHealth Experimental Medicine Centre – AAALAC-accredited facility
- Albany Molecular Research Inc – chemistry research services
- Maccine – pre-clinical research (model development and bio-imaging; AAALAC- and GLP-accredited)
- Translational Interface – sample collection, tissue preparation, biomarker analysis

Accelerating drug discovery & development

The world's leading companies are leveraging Singapore as a key home-base to drive innovation in Asia. Key examples include:

- Roche's Hub for Translational Medicine – Roche entered into a strategic alliance with Singapore's scientific and medical institutions to set up a major new translational research hub in Singapore in January 2010. Bringing together world-class expertise from Singapore's scientific and medical research institutions with Roche's significant capability in translational medicine and clinical development, this new centre will focus on expanding knowledge of disease biology to develop new personalised treatment approaches.
- AstraZeneca has partnered National Cancer Centre Singapore (NCCS) and National University Hospital (NUH) in clinical and pre-clinical development of anti-cancer compounds for patients with inoperable Hepatocellular Carcinoma (HCC). This collaboration will help to build up AstraZeneca's drug development capabilities in Asia and speed up access to new medicines for patients with inoperable HCC, which is particularly prevalent in Asia.
- Bayer Schering Pharma Asia Pacific partnered Yong Loo Lin School of Medicine (National University of Singapore) in a S\$3.5 million translational and clinical research collaboration to develop new anti-cancer therapies. This collaboration will include the profiling of oncology drugs in an Asian context, identifying novel predictive biomarkers and investigating novel tumour models with high relevance to the clinical situation.

Pharmaceutical & Biotechnology Manufacturing

As pharmaceutical and biotechnology companies seek to achieve greater efficiencies while maintaining the highest standards of quality and reliability, Singapore presents a strategic partner to develop innovative manufacturing solutions and pioneer manufacturing excellence.

Strong track record in API manufacturing

Singapore has established a strong track record in chemical-based active pharmaceutical ingredient (API) manufacturing. Leading companies (e.g. GlaxoSmithKline, Merck Sharp & Dohme, Pfizer, sanofi-aventis, Novartis) have invested in about 20 commercial-scale facilities that have achieved high quality standards with no man-hour loss and zero major observations from regulatory authorities worldwide (e.g. U.S. FDA and EMEA). Pfizer and Merck Sharp & Dohme have partnered Tuas Power, which is a leading Singapore-based energy and utilities solutions provider, to tap state-of-the-art trigeneration facilities that can yield greater energy efficiency and cost-savings by producing electricity, steam and chilled water from a single integrated system.

Ready partners in process R&D

Singapore's strong and growing process R&D capabilities are helping companies based here to break new ground in both small-molecule and biologics production. There are currently seven major collaborations between Singapore's public institutes and leading pharmaceutical companies, including a S\$2 million public-private partnership between GSK Biologicals and A*STAR's Bioprocessing Technology Institute to collaborate on vaccine and adjuvant system-related research projects. In 2009, Singapore's Institute of Chemical and Engineering Services (ICES) opened a pilot-scale laboratory facility that will enable greater collaborations with pharmaceutical companies in process development.

Manufacturing novel medicines

Singapore has become a leading site in Asia for biologics manufacturing with leading biotechnology companies (e.g. Baxter, GSK Biologicals, Roche, Lonza) investing US\$2 billion in biologics facilities within the last half of 2000s. Singapore continues to push ahead of the curve in new modalities, as evidenced by a cutting-edge cell therapy facility currently being developed by Lonza.

A commitment to developing manpower for the future

Singapore has established a strong base of more than 4,800 skilled engineers and technicians in the pharmaceutical and biotechnology manufacturing sector. Companies can also access a strong base of more than 300,000 skilled employees in related sectors (e.g. chemicals, electronics, engineering).

Singapore remains committed to further enhancing its manpower capabilities to meet companies' evolving needs. Key talent development initiatives include the National University of Singapore Academy of GxP Excellence (NUSAGE) that offers post-graduate training in pharmaceutical manufacturing, and the GSK-EDB partnership to build up capabilities in sustainable manufacturing. Singapore also actively partners leading companies to train Singaporeans in complex manufacturing processes to facilitate technology transfer. These programmes demonstrate Singapore's commitment to develop a manpower base that is ready for your future manufacturing requirements.



Tuas Biomedical Park (TBP) offers a 360-hectare specialised zoned area for pharmaceutical and biotechnology manufacturing; equipped with a ready supply of water and utilities, established sewerage system and road network, TBP presents a plug-and-play environment that reduces lead time to commence commercial operations.

GlaxoSmithKline: Strengthening partnerships in manufacturing excellence

Starting from a single *amoxicillin* plant in Singapore in 1972, GlaxoSmithKline (GSK) has expanded its manufacturing presence in Singapore to a network of three API production buildings, its first R&D pilot plant in Asia Pacific and a new industrialisation module for improved capabilities and flexibility to introduce new API products. This network will further enhance Singapore's capabilities in chemical-based API manufacturing excellence. In 2010, GSK and EDB awarded the first projects under the S\$33 million GSK-Singapore Partnership for Green & Sustainable Manufacturing which is part of the GSK-Singapore 10-year Strategic Roadmap.

In June 2009, GSK Biologicals opened its first primary vaccines manufacturing plant in Asia, which will produce polysaccharides, recombinant-proteins and conjugates for the manufacturing of GSK's innovative vaccines that provide protection against *Streptococcus pneumoniae*. GSK Biologicals is also working with Bioprocessing Technology Institute (A*STAR) in vaccine and process development to further enhance its manufacturing operations.

Roche: Leveraging Singapore as a base for biologics manufacturing in Asia

In November 2009, Genentech, a wholly-owned member of Roche, opened its first Asia-Pacific biologics manufacturing site in Tuas Biomedical Park, Singapore. With a combined investment of about US\$500 million, the 12.6-hectare manufacturing site comprises two state-of-the-art facilities.

The mammalian-based facility will manufacture *Avastin*, a targeted cancer therapy for multiple cancer tumours; Genentech has acquired this mammalian-based facility from Swiss-based contract manufacturer, Lonza.

Meantime, the microbial-based facility will manufacture *Lucentis*, which is used to treat patients with age-related macular degeneration. In 2010, Genentech was awarded the Facility of the Year Award for Project Execution by ISPE, INTERPHEX and *Pharmaceutical Processing* magazine, for building up this fully-integrated, high-quality microbial-based facility from engineering kick-off through initiation of GMP qualification batches in 24 months. This was achieved in partnership with its contractors Jacobs Engineering Group and Bovis Lend Lease Pharmaceutical.



Roche Singapore Technical Operations is Roche's first biologics manufacturing site in Asia Pacific and comprises a microbial-based facility which received the Facility of the Year Award for Project Execution 2010 (ISPE, INTERPHEX, *Pharmaceutical Processing*) and a mammalian-based facility (insert) which was acquired from Lonza.

Healthcare

The growing base of ageing populations and sophisticated healthcare consumers is driving the demand for more innovative and effective healthcare solutions. Amidst these developments, Singapore presents a lead market for future-oriented healthcare solutions and is an ideal partner for companies and healthcare service providers that seek to develop new solutions to address unmet healthcare needs in Asia and beyond.

Translate first-world into world's firsts

Singapore's strong fundamentals in world-class healthcare delivery and biomedical sciences innovation, together with advanced IT infrastructure, make it the ideal environment for pioneering healthcare excellence. Furthermore, Singapore has an efficient healthcare financing system that is anchored on the twin philosophies of individual responsibility and affordable healthcare for all. Through a unique co-payment system, use of market-based mechanisms to promote competition, transparency and the adoption of technology to improve healthcare delivery, Singapore has achieved good healthcare outcomes while keeping healthcare expenditure below 4% of GDP.

A clear view to a brighter future

Singapore's integrated healthcare system is easy to navigate. Access to the healthcare system is streamlined through regional clusters comprising acute-care hospitals, community hospitals, polyclinics and home-care services. Companies can also work with national specialty centres that focus on key therapeutics (e.g. cancer, cardiovascular diseases, neurodegenerative disease, eye diseases, infectious diseases). In addition, Singapore's integrated healthcare network is underpinned by an electronic medical records exchange system that allows for secured exchange of patient information across public healthcare clusters and community hospitals. Progressive steps are taken to establish a fully integrated national electronic healthcare record system.

Get on the fast track to Asian markets

Asia's fast expanding healthcare markets, which are projected to grow from US\$246 billion in 2009 to US\$349 billion in 2012 (Frost & Sullivan, 2010),

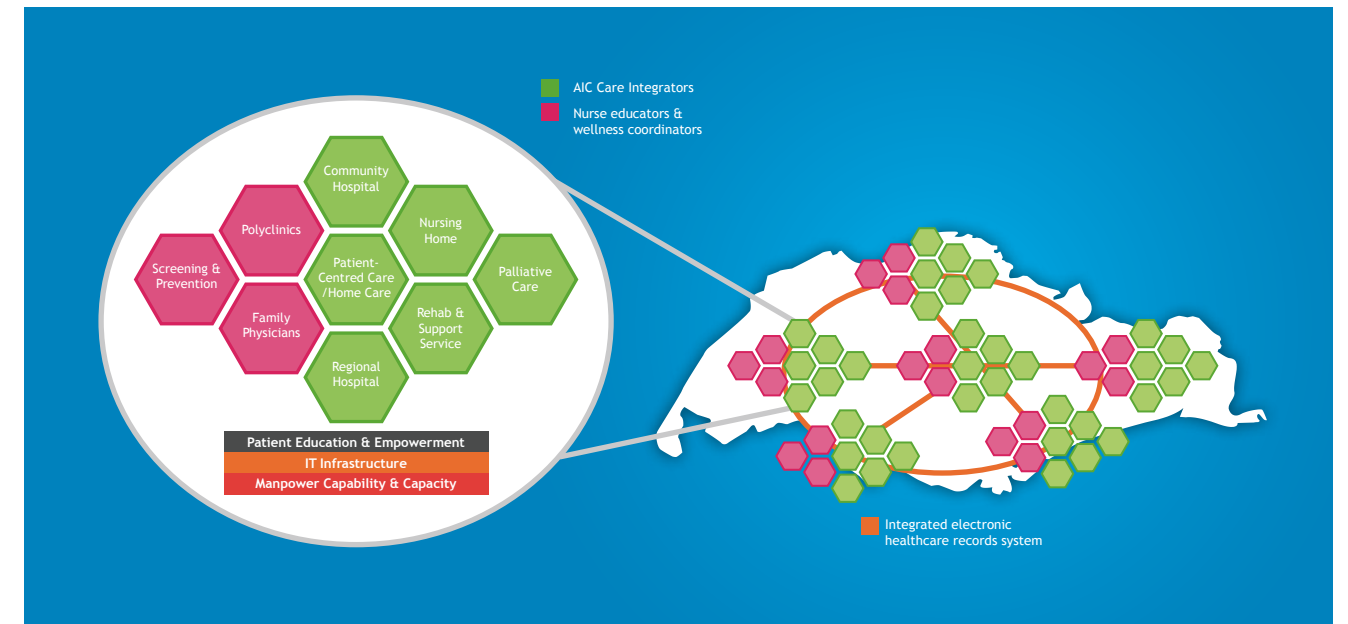
present tremendous opportunities for companies in the healthcare and biomedical sciences sectors worldwide. Leveraging Singapore's pan-Asian market as lead demand as well as the city-state's strong network with clinicians in the region, Singapore presents an ideal location to develop and roll out your innovative solutions to address Asia's unmet healthcare needs. It is also a powerful reference site for subsequent commercialisation, scaling and export of these solutions into Asia and beyond.

Improving Health in Asia

In July 2010, the National University of Singapore (NUS) launched the NUS Initiative to Improve Health in Asia (NIHA), which aims to contribute to thinking and policy-formulation in public health and health systems development in Asia through multi-disciplinary research, high-level policy forums and leadership programmes.

At a glance

- World's 4th best healthcare infrastructure (IMD World Competitiveness Yearbook 2009)
- World's 3rd lowest in infant mortality (WEF Global Competitiveness Report, 2009-2010)
- World's 7th highest in life expectancy (WEF Global Competitiveness Report, 2009-2010)
- National healthcare expenditure constitutes less than 4% of GDP
- Effective healthcare financing that provides multiple tiers of protection and universal coverage for Singaporeans



Singapore has established integrated clusters of healthcare services that are equipped with the requisite infrastructure and capabilities to address the full continuum of care in the city-state's key regions; these clusters are also connected via an integrated electronic healthcare records system.

Hill-Rom: Driving innovation for Asia Pacific in Singapore

Hill-Rom has established its Asia-Pacific Innovation Centre in Singapore to focus on applied development in micro-electronics, embedded software and electro-mechanical systems, all of which are integral to the development of new Hill-Rom beds and therapy surfaces. The centre will also be the home-base for new teams looking at R&D projects for global applications of Hill-Rom products. In 2010, Hill-Rom launched the Patient Support Development Center, which will collaborate with hospitals in Asia to develop new products for the region. Hill-Rom also launched a Respiratory Care Development Center that will identify and develop innovative global respiratory care products.

A*STAR-Tekes: Cross-border collaboration

In January 2010, Singapore's Agency for Science, Technology and Research (A*STAR) and Tekes, the Finnish Funding Agency for Technology and Innovation, announced the first bilateral Joint Call for Proposals (JCP) in areas including healthcare, wellness and ageing. The JCP is part of the 2nd Memorandum of Understanding (MOU) signed by both parties to promote R&D and scientific collaboration. This follows the success of projects under the first MOU, which included the development of an online health monitoring platform that can remotely track the sleep activity of elderly patients. This platform has been successfully tested at a Singapore nursing home, allowing caregivers to monitor and advise their patients from anywhere in the world as long as they have an internet connection.

Dynamic Bio-cluster in Singapore



Medical Technology Innovation

To tap Asia's fast-growing healthcare markets, medical technology (medtech) companies are in the race to develop disruptive innovation and novel products tailored to address the region's unmet healthcare needs. As a leading medtech site in the region, Singapore has built up core capabilities and the requisite talent base to fuel companies' innovation and growth in Asia.

Your listening post in Asia

Strategically located at the heart of Asia, where companies can reach key markets in Asia within a seven-hour flight radius, Singapore presents an ideal listening post to feel the pulse of Asia's fast-growing healthcare markets and identify unique Asian clinical needs for innovation. Coupled with its strong intellectual property protection and its base of voice-of-customer and regulatory specialists, Singapore presents a strong partner to scout for innovation gaps and introduce novel medical devices in Asia's fast-expanding markets.

Strong track record

30 global medtech companies are carrying out R&D activities that include value engineering, product development and process development; they include 3M, AB Sciex, Becton Dickinson, Dx Assays, Essilor, Fluidigm, Hill-Rom, Hoya, Life Technologies, Siemens Medical, Thermo Fisher Scientific, Welch Allyn.

To nurture a vibrant eco-system for local start-ups, SPRING Singapore launched a S\$75 million Technology Enterprise Commercialisation Scheme (TECS) in April 2008 to provide technology start-ups and enterprising public sector researchers with early-stage funding support for POC/POV studies.

Furthermore, Singapore's public-sector research institutes have established strong capabilities in biomedical engineering research that can be translated into novel medical devices.

- Institute of Materials Research & Engineering (IMRE) has developed a new range of patented microneedles that can be used in various drug delivery intervals with minimal pain. This innovative device has attracted a joint venture with Sumitomo Corporation to form a spin-off company called Micropoint Technologies.

- Institute of Bioengineering and Nanotechnology (IBN) has developed an all-in-one automated, portable PCR platform, called the MicroKit, which enables speedy gene extraction and detection from a variety of biological samples. The MicroKit has been licensed by SG Molecular Diagnostics and will be launched in global markets.
- Singapore Immunology Network (SIgN) has developed a portfolio of technologies to create a versatile Personalised Peptide Vaccine (PPV) platform to predict and optimise peptide vaccines for use at an individual and population level. This portfolio of technologies have been licensed to Rhapsody Biologics, who is in talks with major pharmaceutical companies to develop vaccines based on the PPV platform.
- IBN has developed novel drug-loaded contact lenses as well as the world's first photochromic contact lenses and aims to develop contact lenses that darken upon exposure to sunlight to protect the eyes against harmful ultraviolet radiation and glare. IBN is working with Carl Zeiss to develop technologies and treatments associated with IBN's innovative ocular biomaterials.

Access to Asia-ready medtech innovators

Singapore has established a strong foundation in science and engineering with more than 30,000 research scientists and engineers, and an annual cohort of more than 8,500 science and engineering graduates from local universities – National University of Singapore (NUS) and Nanyang Technological University (NTU). This base will continue to grow with the launch of the Singapore University of Technology and Design in partnership with Massachusetts Institute of Technology (MIT) and Zhejiang University.



The 1,000 square-metre Khoo Teck Puat Advanced Surgery Training Centre (ASTC) in National University Health System (NUHS) Campus presents cutting-edge facilities and technology that enable medtech companies to carry out surgical training and pre-clinical research.

In clinical research, Singapore is expanding its base of clinical innovators through graduate programmes at the Duke-NUS Graduate Medical School, National University Health System (NUHS)'s partnership with Harvard University's Beth Israel Deaconess Medical Center in education, research and clinical care, as well as Agency for Science, Technology and Research (A*STAR) Biomedical Engineering Programme that connects research engineers in A*STAR with clinician scientists in Singapore's hospitals to develop cost-effective, innovative and clinically impactful solutions for healthcare systems.

Singapore is aware that medical device innovation is a multidisciplinary process. At the same time, medtech companies require globally-oriented talent who are attuned to Asia's healthcare needs.

Key programmes to address these needs include:

- EDB and A*STAR's collaboration with Stanford University to launch the Singapore-Stanford Biodesign Program.
- A*STAR's collaboration with Boston-based Center for Integration of Medicine and Innovative Technology (CIMIT).
- EDB's Medtech IDEAS (Innovate, Design, Engineer for Asia in Singapore) programme to train multidisciplinary teams of engineers, VOC specialists and regulatory experts in companies' global and Singapore-based R&D facilities.

World-class infrastructure to meet end-to-end research needs

- Starting up: Companies can establish their labs in plug-and-play infrastructure that are equipped with the required amenities, or choose to set up their facilities in phases within the Biopolis or Fusionopolis where they will be co-located with public-sector research institutes.
- Prototyping: Companies can work with public-sector research institutes (e.g. Singapore Institute for Manufacturing Technology – SIMTech, Institute of Microelectronics' wafer foundry), tertiary institutions (e.g. Nanyang Polytechnic) or local suppliers to develop prototypes for POC studies.
- Preclinical & clinical research: Companies can leverage cutting-edge infrastructure and capabilities at NUHS's Advanced Surgery Training Centre or Innoheart for pre-clinical studies, as well as Singapore's 15 hospitals and medical institutes that offer core capabilities in key therapeutics (e.g. cancer, cardiovascular diseases, neurodegenerative diseases, infectious diseases and eye disease). These institutes (e.g. National Heart Centre, Singapore Eye Research Institute) are premier institutes in Asia that can help companies to gather pan-Asian insights.
- Process Development: SIMTech and automation houses are excellent partners for developing processes and technologies to produce innovative devices in commercial quantities.

Medical Technology Manufacturing

While Asia's fast-growing markets present global medical technology (medtech) manufacturers with exciting new growth opportunities, they need to achieve successful technology transfer and maintain high quality standards for their Asia-based operations. In Singapore, you will find the world-class manufacturing capabilities, logistics connectivity and skilled manpower required to build your strategic manufacturing base in Asia.

Tap into a world-class workforce

Singapore's medtech manufacturing sector employs more than 8,200 skilled workers in high-value, complex roles, and this number is set to grow with more than 20,000 science and engineering graduates entering the workforce from Singapore's tertiary institutions each year. Companies can also access a strong base of more than 300,000 skilled employees in related sectors (e.g. pharmaceutical, electronics, engineering). At the same time, government agencies such as the Workforce Development Agency (WDA) and the Employment and Employability Institute (e2i) continue to work closely with industry partners in enhancing manpower capabilities through customised training programmes and skills upgrading schemes.

Connect to global markets

As the world's leading logistics hub in the heart of Asia, Singapore plugs manufacturers into an excellent global network that facilitates an efficient movement of parts and final products. Unparalleled trade connectivity includes 18 FTAs – with key markets such as China, Japan, South Korea, India, Australia and the U.S. – 61 double taxation avoidance agreements and 34 investment guarantee agreements. Leveraging these advantages, global medtech leaders (e.g. Becton Dickinson, Siemens Audiological Group) are managing their global supply chains from Singapore.

High-quality suppliers provide a competitive edge

The strong base of high-quality, ISO13485-certified suppliers in Singapore's medtech sector gives manufacturers here a competitive advantage. Their extensive experience in working with medtech MNCs enables these suppliers to provide manufacturers with the flexibility and quality required to succeed in today's dynamic market conditions, offering such services as plastic injection moulding, precision machining, secondary processes and systems integration.

To facilitate and enhance partnerships between OEMs and suppliers, Singapore has established a number of platforms to ensure that suppliers' capabilities evolve to meet the needs of the industry. They include EDB's Partnerships for Capability Transformation (PACT) scheme and SIMTech's Medtech Manufacturing Consortium.

A global manufacturing centre of excellence

As a global site of manufacturing excellence, Singapore continues to push the frontiers of manufacturing technologies and processes. Through its network of public-sector research institutes, universities and automation houses, companies can tap Singapore's cutting-edge science and engineering capabilities to optimise their operations and carry out process development for new products. Leading medtech companies have also collaborated with automation leaders and innovation partners here to enhance productivity and competitiveness.

Affymetrix: Leveraging Singapore to enhance global manufacturing efficiency

Drawn by Singapore's highly skilled workforce, strong intellectual property protection and stable business operating environment, Affymetrix has consolidated all microarray manufacturing activities within its plant in Singapore to enhance global manufacturing efficiency. Affymetrix' decision to consolidate its entire microarray manufacturing activities in its Singapore facility, within three years of establishing operations here, is a strong vote of confidence for Singapore's competitiveness.

With this expansion, Singapore will account for more than half of the global supply of microarrays, which are increasingly used by scientists to better understand complex disease biologies, and to identify predisposition to diseases.



Affymetrix's Singapore facility achieved ISO 13845 certification in November 2008.

Medtronic: Strategic manufacturing campus to harness Asia's growth

In 2009, Medtronic officially opened its ASIA (ASEAN, South Korea, India, Australia and New Zealand) and international headquarters, which will be co-located with its first-in-Asia cardiac device manufacturing facility in Singapore. The S\$80 million manufacturing facility in Singapore will be a state-of-the-art facility adhering to Medtronic's high quality, safety and compliance standards. The facility will produce select Cardiac Rhythm Disease Management (CRDM) devices and production is expected to commence in 2011. This manufacturing campus will serve as an important base for Medtronic to capitalise on Asia's fast-growing markets.

PSB Technologies: Driving manufacturing innovation

With more than 20 years of experience in designing and building customised automated lines, PSB Technologies delivers innovative design capabilities to medical technology manufacturers in Singapore and around the world. Machines designed and built by PSB Technologies have been installed worldwide in countries that include China, India, Malaysia, Singapore, Europe and the U.S. It is one of the few automation houses in the region that can deliver fully customised automated machines based on customer requirements, and design machines to comply with CE and NRTL requirements.

At a glance

- More than 30 medtech companies manufacture S\$3 billion worth of medical devices in Singapore, employing more than 8,200 skilled workers
- Singapore manufactures 10% of the world's contact lenses, 50% of the world's thermal cyclers and more than half of the world's microarray
- No. 1 in Asia for IP protection (WEF Global Competitiveness Report, 2009-2010)
- World's no. 2 logistics hub (World Bank, 2010)World's easiest place to do business (World Bank, 2010)

Regional Headquarters

While Asia presents huge opportunities for biomedical sciences companies, the region's diversity makes it a challenging market to access. Against this backdrop, Singapore, with its central location, established biomedical sector and world-class business environment, presents an ideal home-base for companies to address this challenge, orchestrate their pan-Asian strategies and drive expansion in the region.

Lead from Asia's best business environment

Singapore's stability, security and pro-business policies combine to reduce companies' operational risk, allowing them to focus on executing strategies to tap the vast potential of Asian markets. In Singapore you will find some of the best business conditions anywhere in the world, including:

- World's easiest place to do business (World Bank, 2010)
- A stable environment with the lowest political risk in Asia (Political and Economic Risk Consultancy, 2010), and the most transparent country in the world (IMD World Competitiveness Yearbook, 2009)
- The best intellectual property protection in the world (WEF Global Competitiveness Report, 2009-2010)
- 18 FTAs covering 60% of the world's GDP, and 61 double taxation avoidance agreements
- A pro-business tax environment, with a corporate tax rate of 17%

Strong Track Record

More than 30 leading global biomedical sciences companies, which include 8 of the top 10 pharmaceutical companies and all of the top 10 medtech companies, have established international or regional headquarters in Singapore. Key examples include Abbott, AstraZeneca, Bayer, Boehringer Ingelheim, Boston Scientific, Bristol Myers Squibb, CibaVision, Eisai, GE Healthcare, Genzyme, GlaxoSmithKline, Johnson & Johnson, Medtronic, Merck Sharp & Dohme, Quintiles, Roche, Takeda, sanofi-aventis.

Connecting you with Asia and global markets

Singapore's global connectivity and deep understanding of regional markets offers unparalleled access to opportunities in Asia and around the world. Companies can tap Singapore's base of regulatory and voice-of-customer regulatory specialists to scan the regional landscape, identify opportunities and accelerate new product introduction in Asia. Leveraging a strong base of talent who are grounded in science and business, companies also carry out clinical trial coordination and business development in Asia from their base in Singapore. As the world's no. 2 logistics hub (World Bank, 2010), Singapore is well connected via a strong network of air and sea linkages, and leading biomedical sciences companies have set up global procurement and supply chain management control towers here.

"Singapore is one of Abbott's most important worldwide locations. We value Singapore's strategic location, employee talent pool, transportation infrastructure, and policies that support our growing operations throughout the Asia-Pacific region."

*Ramachandran Rajamanickam,
Vice President, Pacific Asia Africa Area, Nutritional Products, Abbott.*

Access to Asia-ready global talent

Singapore provides companies with access to the talent required to develop healthcare solutions for Asian markets and drive regional expansion. An open immigration policy and excellent standard of living facilitate the attraction of talent from Asia and around the world, while a qualified and experienced base of local talent offers world-class support to companies' business operations.

Leading global institutes of higher learning, such as the Lee Kuan Yew School of Public Policy, INSEAD, the University of Chicago Booth School of Business, S P Jain Center of Management, Shanghai Jiaotong University and Singapore Management University, provide the opportunity not just to recruit talent, but also to develop and train existing staff to be ready for Asia and global markets. As part of GSK-EDB's 10-year strategic roadmap, a joint endowment fund was launched in 2009 to support graduates in public health policy research.

Singapore also seeks to draw leading global talent in specific disciplines that are relevant to the industry. In 2009, Prof David Bruce Matchar, formerly a director of the Center for Clinical Health Policy Research from Duke University Medical Centre, received the Singapore Translational Research (STaR) Investigator Award to do research in optimising health services and systems to promote effective and sustainable healthcare. Prof Matchar is also heading the Programme in Health Services and Systems Research at Duke-NUS Graduate Medical School Singapore.

Abbott: Managing diverse businesses in Asia Pacific from Singapore

The company's Asia-Pacific headquarters in Singapore manages strategic planning and marketing for its businesses in pharmaceuticals, nutrition, vision care, diagnostics and diabetes care in the region. Abbott's largest nutrition manufacturing plant is in Singapore, and the company has nutrition and pharmaceutical research and development laboratories in Singapore's Biopolis.

Novartis: Locating regional functions in Singapore

Recognising the unique opportunities offered by Singapore, Swiss pharmaceutical giant Novartis has located various functions of its Regional Business Units in Singapore. These functions include strategic planning and development, marketing control and brand management for the Asia-Pacific region. In addition, the company has set up the Novartis Institute for Tropical Diseases, and two major global supply sites for pharmaceuticals and contact lenses in Singapore.



As a leading global business city and a leading international bio-cluster in Asia, Singapore is a strategic home-base for global and Asian biomedical sciences companies to manage and control their pan-Asian business activities.

A Home for Global Talents

A cosmopolitan, vibrant and dynamic global city, Singapore has become the second home for international talents who enjoy a high quality of life and the opportunity to comfortably work, live and play.

The best of all worlds

Situated in the heart of Asia, yet with a strong influence from its colonial past, Singapore is a city at the confluence of East and West. It is a place where Asian and Western cultures blend together in a unique mix of tradition and modernity, bringing out the best of each element. For global scientific and business talent, Singapore presents a home where they can achieve a fulfilling, dynamic and balanced lifestyle.

A cosmopolitan lifestyle

Close to one-quarter of the population is made up of foreign residents, giving Singapore a truly international feel. A vibrant arts and culture scene includes a busy schedule of theatre and musical performances, art and museum exhibitions, as well as cultural festivals. The city is also home to the world's first Formula One night race and a Universal Studios theme park. In 2010, two integrated resorts, which include world-class hotels, convention and entertainment facilities, and casinos, will open their doors. And for food-lovers, you can look forward to a great variety of cuisine from authentic Asian flavours to world-class Western cuisine.

Marina Bay Sands integrated resort (right) will enhance Singapore's vibrant city-scape where visitors and residents can access a host of entertainment, convention, theatre facilities alongside a casino that are developed by Las Vegas Sands.



A city that really works

Renowned for its efficiency, cleanliness and safety, Singapore is often described as a city where "everything really works". From the moment you enter the country, you'll be struck by the efficiency, modernity and friendliness you encounter at every turn. From its world-class transport infrastructure and English-speaking population, to the ease of navigating immigration procedures and setting up a home here, global talent find Singapore a city that welcomes them with open arms and makes them feel right at home.

"Smart people want to be around other smart people, one learns from one's peers and if your peers are excellent, you become better as a result. I love living in Singapore, with its international community and the multi-cultural aspects."

*Prof Edward Holmes, Executive Chairman, National Medical Research Council (Singapore) moved to Singapore in 2006 with his wife Prof Judith Swain, who heads the Singapore Institute for Clinical Sciences (A*STAR).*

Ideal for families

For global talent who are looking to settle abroad with their families, they can be assured of an ideal environment to raise their children. Singapore is one of the safest countries in the world, and has a wide selection of top-quality schools that offer a range of curriculums and languages of instruction. Singapore is also a place where children can enjoy adventures in a clean, green environment with numerous parks and nature reserves around the island.

"My kids are happy in school, with many friends here. One of them is learning to speak Mandarin, making very good progress. One thing that marvels me most is the security in Singapore. I allow my young children to commute around independently—something I would never allow outside Singapore."

Mr Vincent Hingot, Site Director, GlaxoSmithKline Biologicals, who moved to Singapore in 2007.



Singapore is Asia's top city for quality of life (Mercer, 2009), and offers world-class education for expatriates' children.



The 'SARS Inhibited' sculpture (by environmentalist and sculptor Mara Haseltine), on display at Biopolis, is inspired by a breakthrough finding on the protein structure of the SARS virus. When SARS broke out in Singapore in March 2003, researchers from A*STAR institutes worked quickly together to sequence its genome, and developed an antibody-based test kit to rapidly detect the virus in humans. This artwork symbolises the common commitment to develop biomedical sciences research capabilities for Singapore's continued economic and social well-being.

About the Singapore Economic Development Board

Singapore Economic Development Board (EDB) is the lead government agency for planning and executing strategies to enhance Singapore's position as a global business centre and grow the Singapore economy. We dream, design and deliver solutions that create value for investors and companies in Singapore. In so doing, we generate economic opportunities and jobs for the people of Singapore; and help shape Singapore's economic future.

'Host to Home' articulates how EDB is sharpening its economic development strategies to position Singapore for the future. It is about extending Singapore's value proposition to businesses not just to help them improve their bottom line, but also to help them grow their top line. EDB plans to build on existing strengths and add new layers of capabilities to enable Singapore to become a 'Home for Business', a 'Home for Innovation' and a 'Home for Talent'.

For more information about Singapore's biomedical sciences sector, please visit:
www.biomed-singapore.com or
www.sedb.com/medtech
www.sedb.com/healthcare

FUTURE READY
singapore

What is Singapore: Future Ready?

Singapore: Future Ready articulates Singapore's aspiration to be an ingenious partner for global businesses as they develop their ideas for tomorrow's solutions. We do so by recognising the value of long-term relationships, adopting a forward-looking approach, and taking on challenges with a can-do spirit. Against the backdrop of an ever-changing economic landscape, it also underlines Singapore's unique ability to help companies deliver solutions more quickly, with the right combination of talent, innovation, and strategic leadership.

Pictures courtesy of Advanced Surgery Training Centre (NUHS); Affymetrix; Agency for Science, Technology and Research (A*STAR); Roche; Singapore Tourism Board, United World College South East Asia.

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