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EDB SINGAPORE

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Singapore — The Biopolis of Asia

Where talent fuels science and business

EDB SINGAPORE

Welcome to ‘Singapore – The Biopolis of Asia’

Foreword

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Biomedical Sciences
Singapore Economic Development Board

Located at the heart of Asia, Singapore presents an ideal home-base for global businesses, innovation and talent in the region.

Singapore has established its position as a global site for pharmaceutical and medical technology manufacturing. In addition, more than 50 biomedical sciences companies are carrying out R&D activities that include drug discovery, translational and clinical research, as well as medical technology innovation, many of them through new partnerships and business models. A growing number of companies have also established their regional headquarters in Singapore to expand their outreach into Asian markets.

Since the year 2000, when Singapore launched its biomedical sciences initiative, the Singapore Economic Development Board (EDB) has worked closely with other 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. In 2006, we launched phase II of the biomedical sciences initiative, which will focus on building up strong translational and clinical research expertise, while strengthening our basic science capabilities.

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 more than S$5 billion in building up industrial, human and intellectual capital thus far, and remains fully committed to developing this sector.

I invite you to join our fast growing community of global biomedical sciences companies in Asia’s leading biomedical cluster!

Early Research and Innovation

Singapore presents a hotbed of early research and innovation, where companies can access excellent science, world-class partners and a global talent base.

Excellent science

Singapore has an established research community that includes 15 A*STAR public-sector research institutes, 2 leading universities and 2 medical research campuses. Their intellectual output has ranged from publications in high-impact journals, approved and filed patents, partnerships with industry players, and spin-off companies.

In 2005, the Genome Institute of Singapore developed a PCR-based diagnostic kit to detect the H5N1 virus. In January 2009, A*STAR's Institute of Molecular and Cell Biology was the first to discover and characterise a human protein called Bax-beta involved in the apoptotis pathway, which could lead to new approaches in cancer treatment.

Biopolis: Dynamic and close-knit research community

More than 2,000 academic and industry scientists rub shoulders in this 2.4 million square foot research campus, which co-locates public-sector and private-sector labs. In addition, companies can work with medical institutes in the adjacent Kent Ridge Campus, which focuses on the National University Health System.

Access to scientific talent

Singapore's exciting research environment, high quality of life and open immigration policies have been a draw for both global and regional talents. Today, more than 2,000 foreign researchers are based here, alongside an annual cohort of more than 8,500 graduates in science and technology from Singaporean universities, including more than 2,500 postgraduate students.

Plug and play infrastructure

The Biopolis' robust infrastructure allows research-based organisations to rapidly establish operations with minimal upfront capital outlay. Scientists and researchers can tap into 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 SPF containment facilities.

Excellent intellectual property protection

Companies can develop their latest products and therapies with ease of mind in Singapore, which is ranked world No. 2 in intellectual property protection by the World Economic Forum (WEF) and the International Institute for Management Development (IMD) in 2009.

At one glance

For the year 2007,

- GERD: 2.61% of GDP
- 104 researchers per 10,000 labour force
- 1,739 patents applied; 941 patents awarded
- A*STAR's research units are staffed by 2,541 researchers
- Tertiary institutes (including National University of Singapore, Nanyang Technological University, Duke-NUS Graduate Medical School) were staffed by 4,879 researchers
- 1.41 papers published per 1,000 people (Wiley-Blackwell, 2007)
- Journal publications by A*STAR biomedical research units: 392

European biotechs tap SIgN's expertise

French biotech, Humalys SAS, is partnering the Singapore Immunology Network (SIgN) to isolate human monoclonal antibodies and to build an antibody platform for studies into their therapeutic efficacy. This collaboration seeks to accelerate the development of antibody-based therapies for use against viral diseases prevalent in Asia.

In addition, Swiss-based Cytos Biotechnology will work with SIgN to develop fully human monoclonal antibodies for combating and managing Enterovirus 71, a common virus responsible for Hand, Foot and Mouth Disease (HFMD).

Lilly: Partnering public research organisations, advancing drug discovery

Lilly Singapore Centre for Drug Discovery (LSCDD) has partnered the National Neuroscience Institute and the Singapore Institute for Clinical Sciences (SICS) to advance drug discovery, using adult brain tumour stem cells.

"Discovering new, breakthrough medicines through translational and clinical research requires intensive collaborations amongst partners. This research collaboration with clinicians and scientists from NNI and SICS will bring together different expertise and resources. This fits well with Lilly's new collaborative model known as the Fully Integrated Pharmaceutical Network (FIPNET) model."
— Jonathon Sedgwick, Managing Director and Chief Scientific Officer, LSCDD

Companies in Singapore

- CellResearch Corp — stem cell research
- CordLife — stem cell research
- GlaxoSmithKline — neurodegenerative diseases research
- Lilly — cancer and diabetes drug/ biomarker discovery
- Lynk Biotechnologies — formulation and delivery
- MerLion Pharma — natural product research
- Novartis — dengue fever, tuberculosis and malaria research
- PharmaLogicals — biomarker discovery, cancer research
- Schering-Plough — biomarker discovery
- S*BIO — drug development for oncology
- SGAustria — cell therapy
- Takeda — target validation and pharmacology

More than 2,000 researchers in private and public-sector labs are co-located in the Biopolis.

Translational Research

Singapore has built up integrated capabilities in basic science through to clinical research, which enable companies to carry out through-train drug candidate to proof-of-concept activities to accelerate innovation.

World-class clinical excellence

With one of the most sophisticated and efficient healthcare systems in the world, and a vibrant early research community in the life sciences, Singapore is well-positioned to swiftly execute translational research in an integrated fashion. First-world healthcare outcomes are delivered by a large tertiary hospital network accredited by the Joint Commission International (JCI) and Association for the Accreditation of Human Research Protection Programs (AAHRRP), internationally-trained doctors, and efficient clinical data capture from birth.

Cutting edge capabilities and infrastructure to accelerate candidate-to-POC process

Singapore has established cutting-edge capabilities and infrastructure to handle complex bench-to-bed and bed-to-bench translational research projects. This helps companies move promising candidates more rapidly to the proof-of-concept stage. Developments include:

- Establishing dedicated clinical bio-imaging research, bio-safety, early-stage research trial facilities
- Creating unique preclinical predictive disease models
- Building platform technologies in genomics and bio-imaging

Enabling pharmacovigilance through integrated networks

Translational research requires collaboration, standardisation, data sharing and integration. The tight linkages between Singapore's research base and healthcare delivery system has created an ecosystem, where research data and information can be efficiently generated, managed and analysed. This further supports pharmacovigilance, healthcare outcomes and data monitoring.

Grooming clinician-scientists with an integrated perspective

Through various schemes such as the Singapore Translational Research Award, our very own Howard Hughes Medical Institute Investigatorship award, which is targeted at recruiting top scientific talent, and training schemes for budding medical researchers, Singapore is looking to nurture a cadre of clinician investigators and clinician-scientists by 2015. In addition, Singapore is investing in facilities that will house research, education and training at single locations. They include the Centre for Translational Medicine at the National University Health System and the Singapore General Hospital's Pathology Building, which is proximate to the Duke-NUS Graduate Medical School.

Combining disease and clinical insights to address unmet needs in Asia and globally

Singapore's research environment, researcher base and initiatives (e.g. Translational and Clinical Research Flagship Programmes) enable clinicians and scientists to combine disease biology and clinical insights to address unmet medical needs. To support their global research efforts, companies can work with multiple partners in Singapore to elucidate disease mechanism, run complex investigational medicine trials, and perform long-term cohort studies in diseases such as diabetes, gastric cancer and CNS.

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 on diseases which 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.

AstraZeneca: Collaborating with Singapore institutions to help cancer patients

AstraZeneca has partnered the 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 (liver cancer). This collaboration will develop compounds that have undergone initial clinical testing in the West, and will build AstraZeneca's drug development capabilities in Asia.

Schering-Plough: Translating research into tomorrow's treatments

In February 2009, Schering-Plough opened its first Translational Medicine Research Centre (TMRC) that will support the company's global R&D programmes, by focusing on biomarker discovery and development across various therapeutic areas. The TMRC also will be the company's focal point for non-invasive imaging for discovery research and early clinical development.

At one glance

- Healthcare spending: 4% of GDP
- S$1.55 billion invested to build up capabilities and infrastructure
- Two academic investigational medicine units
- Kent Ridge campus (co-located next to Biopolis), comprising of National University Health System, Cancer Science Institute of Singapore and Centre for Translational Medicine
- Outram campus comprises of Singapore General Hospital, Duke-NUS Graduate Medical School and specialty disease centres
- Translational and Clinical Research Flagship programmes in 5 areas - cancer, cardiovascular/metabolic disorders, neurosciences, infectious diseases and eye diseases
- More than 600 clinical research publications in 2007

Companies that have set up translational labs include:

- PharmaLogicals — biomarker discovery and cancer research
- Lilly — oncology biomarker research, genomic data analysis

Companies undergoing clinical activities include:

- Abbott — Phase 1 and 2 trials conducted with local hospitals
- Lilly — Phase 1 unit (only unit outside the US), 15 studies per year
- Pfizer — Phase 1 unit (only unit in Asia), 40 studies per year
- S*BIO — Phase 1 trials

Companies/resources supporting translational research include:

- Albany Molecular Research Inc — chemistry process development, bioassay development
- Biological Resource Centre — 10,000 sqm animal facility with breeding and husbandry services
- Maccine — preclinical research (model development and bio-imaging)
- Translational Research Interface — sample collection, tissue preparation, biomarker analysis
- Tissue repositories at public hospitals

Singapore's public hospitals and national specialty centres have established a strong track record in partnering companies for translational and clinical research.

Clinical Trials and Healthcare

As companies expand their clinical research activities in Asia, Singapore offers world-class scientific and clinical excellence for companies to conduct and manage clinical trials.

World-class integrated healthcare system

Singapore's integrated healthcare system is ranked 6th worldwide (World Health Organisation) and delivers quality services in a timely and efficient manner. In 2007, Singapore's National Healthcare Group received full accreditation from the Association for the Accreditation of Human Research Protection Programs (AAHRPP). In addition, Singapore's system of tertiary referral centres allows for access to patients with acute disease in single locations. For example, companies can partner with National Cancer Centre for cancer studies and National Heart Centre for cardiovascular diseases.

Trusted clinical research base

Singapore is home to global clinical research organisations (CROs) and the clinical development units of major pharmaceutical companies. They are drawn to our clinical excellence and strict adherence to international standards and ethical guidelines. In 1998, the Health Sciences Authority (HSA) implemented the Singapore Guideline for Good Clinical Practice (SGGCP), which was adapted from the International Conference on Harmonisation (ICH) Guideline for Good Clinical Practice (GCP).

In addition, companies have leveraged Singapore's pro-business environment, our base of well-trained clinicians and English-speaking population to manage and carry out regional clinical development activities (e.g. first-in-man studies). Furthermore, Singapore's bilingual education policy has strengthened our position as a choice location for companies' regional hubs that provide training in areas such as QA, data management and trial protocol design.

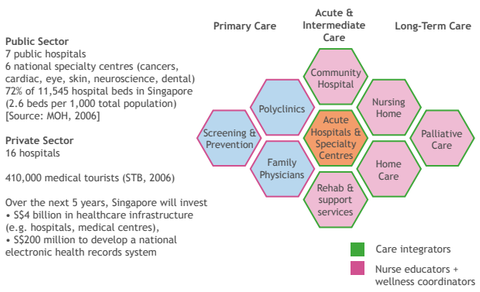
Ideal reference market

Healthcare spending in Singapore is expected to rise with its ageing society, changing disease profiles and knowledgeable patients. Its ethnically-diverse population is representative of Asia, making Singapore an ideal reference market.

Asia's living lab

Companies in areas such as IT systems, medical equipment and consumer businesses can partner with healthcare service providers in Singapore to test-bed their solutions. Leveraging Singapore's Asian population base, companies can develop and test new ideas for the expanding Asian markets and beyond.

Singapore Healthcare System



Public Sector
7 public hospitals
6 national specialty centres (cancers, cardiac, eye, skin, neuroscience, dental)
72% of 11,545 hospital beds in Singapore (2.6 beds per 1,000 total population) [Source: MOH, 2006]

Private Sector
16 hospitals

410,000 medical tourists (STB, 2006)

Over the next 5 years, Singapore will invest
- S$4 billion in healthcare infrastructure (e.g. hospitals, medical centres),
- S$200 million to develop a national electronic health records system

At one glance

- 2.6 beds per 1,000 patients (2006)
- 253 clinical trial certificates approved in 2007
- 4-6 weeks for clinical trial certificate review/approval; applications are made in parallel to regulatory body and institutional review board.
- Therapeutic areas include oncology, clinical pharmacology, cardiology, neurology, gastroenterology, hepatology, urology, infectious disease, immunology and endocrinology
- 181 product licenses issued in 2008 (including 19 new drugs)
- Multi-ethnic population: 77% Chinese, 14% Malay and 8% Indian

Quintiles: The region's largest clinical development organisation

To meet the growing demand for its business in the Asia-Pacific region, Quintiles announced that it would expand its regional headquarters in Singapore. When completed, the new 80,000 square feet facility will house Quintiles' Central Laboratory and Clinical Development Services offices. Quintiles also carries out clinical research training for its regional offices.

"Our growth in Singapore has been bolstered by the expanding base of companies and research institutes in Singapore's larger biomedical sciences research community. We are projecting continued strong growth in the future, and this new facility gives us the room we will need. The new location also will allow us to work more efficiently, share best practices and deliver truly turnkey solutions to our customers."
— Anand Tharmaratnam, CEO, Southeast Asia, and Head of Clinical Development, Asia-Pacific, Quintiles

Companies that are carrying out clinical trial coordination and later phase trials in Singapore include:

- Abbott
- AstraZeneca
- Bristol Myers Squibb
- Eisai
- GlaxoSmithKline
- Merck Sharp & Dohme
- Novartis
- Sanofi-Aventis
- Takeda

Health Sciences Authority: Regional leader in healthcare regulations

Singapore's national regulator for health products, the Health Sciences Authority (HSA), has forged strategic alliances with HSA's counterparts in other countries to enhance the protection of public health without compromising access to health products that meet appropriate standards of safety and quality. The regulatory frameworks and requirements implemented by HSA are aligned with the recommendations of the International Conference on Harmonisation (ICH) and Global Harmonisation Task Force (GHTF) for medicinal products and medical devices respectively.

Through the various product working groups under the ASEAN Consultative Committee on Standards and Quality (ACCSQ), HSA plays active roles in the regional initiatives to harmonise regulatory requirements and standards of various categories of health products, namely pharmaceutical products, medical devices, traditional medicines & health supplements, and cosmetic products.

Contract research organisations in Singapore include:

- Covance — clinical trial management, central lab services
- ICON — clinical trial management, central lab services, data management
- Gleneagles CRC — clinical trial management, site management, biometrics, bioequivalence
- MDS Pharma Services — clinical trial management, data management
- Quintiles — central lab services, clinical trial management and supplies, regional training

Singapore can support end-to-end clinical trials

Running early-in-human/ microdosing and First-in-Human Trials (Phase 0 and 1)
- NUHS investigational Medicine Unit
- SingHealth Investigational Medicine Unit

Running multi-centre trials in Singapore (Phase 2a, 2b, 3)
- Polyclinics — large primary healthcare centres
- Large intergrated public hospital network
- National specialty centres in cander, cardiovascular disease, and CNS/neurology
- Singapore Clinical Research Institute: one-stop shop tp coordinate Ph 2 tirals with local hospitals and clinicians

Running/coordinating multi-centre trials in the region (Phase 2, 3 and 4)
- Regional disease networks including hospitals from Singapore and rest of Asia-Pacific
- Large base of CROs with extensive regional netwoks
- Singapore as Hub for clinical trial coordination, site monitoring, project management and pharmacovigilance

Medical Product Innovation

Growing healthcare needs and private consumption are driving the expansion of Asia's medical product market. For companies that seek to innovate for Asia, Singapore presents a one-stop location for companies to innovate, design and test new medical devices.

Collaborating with research institutes

Singapore's network of public research institutes has a strong track record for collaborating with the industry in areas of R&D and technology transfer. These institutes span biomedical sciences, physical sciences and engineering, thereby allowing companies to tap on the synergies in these fields to develop new medical devices.

Supporting early-stage product development

Companies can work with well-regarded medical institutes in Singapore, which have built up a strong track record with global medical technology companies in early-phase clinical trials. In addition, Singapore's strong engineering base also enables companies to quickly develop prototypes for proof-of-concept studies.

The Asian test-bed

Located at the centre of Asia's emerging medical product market, Singapore's advanced healthcare system is well-managed and highly integrated. Its intellectual property (IP) regime is robust and IP enforcement is strong. These factors make Singapore an attractive "Living Lab", where companies can test-bed their most advanced technologies and develop their latest products for Asia and beyond.

At one glance

- Singapore has a leadership position in manufacturing, producing:
  - 50% global supply of thermal cyclers
  - More than 50% of global supply of micro-array
  - 10% of the world's contact lens
- Base of ISO 13485 local suppliers
- National Research Foundation and SPRING Singapore have announced S$125 million in grant support for proof-of-concept studies

Institute of Bioengineering and Nanotechnology has patented a technology platform for miniaturised aqueous bioassays, DropArray™, which was licensed to Nanostart AG. (Photo courtesy of the Institute of Bioengineering and Nanotechnology)

Hill-Rom: Accelerating efforts through Innovation Centre

Hill-Rom has established its Asia-Pacific Innovation Centre in Singapore, which focuses on applied development in micro-electronics, embedded software and electro-mechanical systems that are integral to the development of new Hill-Rom beds and therapy surfaces. This centre will also be the home base for new teams looking at R&D projects for global applications of Hill-Rom products.

"Our Innovation Centre in Singapore represents an acceleration of our efforts to embed increasingly sophisticated and differentiated micro-electronics and software in our products. We also see the opening of this centre as an important step in globalising our products and presence. Singapore, with its regional reputation for advancing technology development and innovation, its similarities to North America in terms of its healthcare environment and its proximity to the broader Asia-Pacific region made it a natural choice."
— Peter Soderberg, President and CEO, Hill-Rom

Dx Assays: Developing molecular diagnostic assays

A joint venture between Qiagen and Bio*One Capital, DxAssays will support biotech and pharmaceutical companies by developing and validating molecular diagnostic assays to identify promising drug candidates in a more cost-effective and efficient manner, and designing companion diagnostics that demonstrate the efficacy of drug candidates for specific patient populations.

"Our location here in Singapore is ideal for this, as we can leverage upon the strong scientific community here to gain access to qualified manpower, R&D partners and potential clients."
— Michael Paumen, CEO, Dx Assays

Other companies that have set up innovation centres include:

- Amaranth Medical — R&D of biodegradable drug eluting stents
- Applied Biosystems — R&D on thermal cycler and sequence detection systems
- Becton Dickinson — Asian R&D centre for needles and syringes, Bioventure Centre (R&D on bionutrients, assay development, biomarkers, bioinformatics)
- Fluidigm — Biomedical Product Development Centre for research instruments and process R&D
- PerkinElmer — centre of excellence for analytical instruments
- Thermo Fisher Scientific — global product development centre for electrochemistry-based water analysis instruments
- Welch Allyn — Asian R&D centre for diagnostic and monitoring medical instruments

In October 2008, Singapore launched the Fusionopolis, which houses A*STAR's research institutes that specialise in physical sciences and engineering. The close proximity of Fusionopolis with the Biopolis provides a unique opportunity to cross-pollinate ideas across scientific disciplines, and drive medical product innovation.

Dynamic Bio-cluster in Singapore

Cancer Science Institute, Singapore
Centre for Translational Medicine

NUHS
National University Health System
National University Hospital
NUS Yong Loo Lin School of Medicine
NUS Faculty of Dentistry
National University Cancer Institute, Singapore
National University Heart Centre, Singapore

AVALON MEDICAL SERVICES
illumina
MDS Analytical Technologies
Science advancing health
3M
MERLIN MD
Baxter
Hill-Rom
Applied Biosystems
part of life technologies

Abbott
A Promise for Life
Agency for Science, Technology and Research
GlaxoSmithKline
Lilly
NOVARTIS
PharmaLogicals
Schering-Plough
SGAUSTRIA
Takeda

Alcon
PHILIPS

Singapore General Hospital
SingHealth
DUKE NUS
GRADUATE MEDICAL SCHOOL SINGAPORE
National Cancer Centre Singapore
SingHealth
National Neuroscience Institute
SingHealth
Singapore National Eye Centre
SingHealth
National Heart Centre Singapore
SingHealth
MINISTRY OF HEALTH
SINGAPORE
HSA

INSTITUTE of MENTAL HEALTH
KK Women's and Children's Hospital
SingHealth
Changi General Hospital
SingHealth
Tan Tock Seng HOSPITAL
NATIONAL SKIN CENTRE
clearlab
Singapore HealthPartners
Fluidigm
Waters
BIOSENSORS INTERNATIONAL
Bristol-Myers Squibb
Edwards

NANYANG TECHNOLOGICAL UNIVERSITY
COVANCE
Dräger
Agency for Science, Technology and Research
FORMA THERAPEUTICS

KENT RIDGE CAMPUS

SCIENCE PARKS

BIOPOLIS

OUTRAM CAMPUS

Menicon
CellResearchCorp
ThermoFisher SCIENTIFIC
TR
PerkinElmer For the Better
SIEMENS medical
QIAGEN

ONE-NORTH
Biopolis
Fusionopolis
Science Parks

THOMSON MEDICAL CENTRE
Roche
zimmer
Parkway Holdings
RafflesHospital
INNOHEART
Joint Commission International
Pfizer
Abbott
A Promise for Life

BUSINESS DISTRICT

TUAS BIOMEDICAL PARK

BD
GlaxoSmithKline
Schering-Plough
sanofi aventis
kaneka
AFFYMETRIX

Abbott
A Promise for Life
CIBA VISION
Genentech
IN BUSINESS FOR LIFE
GlaxoSmithKline
Lonza
MSD
NOVARTIS
Pfizer
Wyeth

ABIO
amaranth medical
AMRI
cordlife one chance, one choice.
GE
maccine
Medtronic
MITSUBISHI PHARMA
QUINTILES
S*BIO
Waters

EDB SINGAPORE
Bio*One SINGAPORE
Boehringer Ingelheim
BAYER
CardinalHealth
Eisai
EPS International
GlaxoSmithKline
MSD
NOVARTIS
Omnicare Clinical Research
Pfizer
Schering-Plough
sanofi aventis
Takeda

Regional Headquarters

Singapore is a strategic base for companies to navigate Asia's complexities and diversities, and harness the region's opportunities.

Pro-business environment

Singapore's pro-business, stable environment and supportive government policies have drawn companies to locate their regional headquarters here. In addition, Singapore's position as a global financial hub, our strong IP protection, favourable tax and regulatory regime have also led to a rising number of companies that are establishing Financial and Treasury Centres here, to manage cross border transactions such as royalty streams and capital investments.

Excellent connectivity and infrastructure

Singapore has established excellent logistical connectivity that provides easy access to key global markets. Third party logistic companies have also set up dedicated facilities for the biomedical sciences industry in Singapore, including cold-chain management.

High quality of life

Singapore is an ethnically and culturally diverse cosmopolitan city-state, offering the best quality of life in Asia. Top businesses and scientific talents have chose to make Singapore their second home, being attracted to its English-speaking base, excellent education system and vibrant lifestyle. In addition, Singapore's bilingual education policy and its multi-ethnic population's cultural proximity to regional markets, present a ready pool of skilled talent that can manage and implement companies' regional outreach.

At one glance

Singapore is:

- World's Easiest Place to do Business (World Bank 2008-2009)
- World's Top Logistics Hub (World Bank 2007)
- No.2 in the world for IP protection (Global Competitiveness Report 2008-9, World Economic Forum)
- Well connected through its airport (>4,000 weekly flights) and sea port (>200 shipping lines link to 600 ports in 123 countries)
- Accessible to key Asian markets within seven hours by flight
- Connected to the most extensive network of FTAs in Asia, having concluded 19 FTAs that cover 60% of the world's GDP
- Cosmopolitan city-state with foreigners making up 25% of population

Companies in Singapore

More than 20 leading biomedical sciences companies have established regional headquarters in Singapore. They include Abbott, AstraZeneca, Bayer Schering Pharma, Boehringer Ingelheim, Bristol Myers Squibb, Edwards Lifesciences, Eisai, Genzyme, GlaxoSmithKline, Johnson & Johnson, Sanofi-Aventis, Schering-Plough, Roche, Merck Sharp & Dohme, Takeda.

Abbott: Managing diverse businesses in Asia-Pacific

Abbott has located its Asia-Pacific headquarters that will manage strategic planning and marketing for Abbott's businesses, which include pharmaceuticals, nutrition, vision care, diagnostics and diabetes care in the region. To fully leverage the advantage of a strategic regional base in Singapore, Abbott has also set up its first Southeast Asian pharmaceutical analytical research laboratory and its largest nutrition global manufacturing plant in the city-state. In addition, Abbott has announced its decision to open the company's Asia-Pacific Research and Development Centre for Nutrition Science at the Biopolis.

"Singapore presents a strategic location for Abbott to get closer to our customers in both proximity and in understanding the unique needs and preferences of Asians."
— Ramachandran Rajamanickam, Vice President, Pacific Asia Africa Area, Nutritional Products, Abbott

Takeda: Setting up base for expansion in Asia

Takeda Pharmaceutical Company has set up Takeda Pharmaceuticals Asia (TPAsia) in Singapore, which supervises sales and marketing in Taiwan, Thailand, the Philippines, Indonesia and China, while also being responsible for the planning and implementation of geographical expansion in Asia and Oceania. TPAsia promotes optimal sales and marketing strategies for the Pan-Asian/Oceania region from both medium-term and long-term perspectives. In addition, TPAsia works closely with Takeda's regional clinical trial coordination centre, which is also located in Singapore, to further enhance Takeda's marketing and development function.

"From Singapore, you can go to any major city in Asia in seven hours. Also, the common language is English, which is another great advantage, and there are high-calibre, talented people in the market. Even though the competition is keen, you can recruit very high-quality people here. So these combined gives us a very strong competitive edge in Singapore."
— Yasuchika Hasegawa, President, Takeda Pharmaceutical Company (in an interview with Business Times, December 2008)

As the world's easiest place to do business, Singapore presents a strategic base for companies that seek to expand into Asia and for Asian companies that seek to globalise.

Manufacturing

Global companies manage their risks by diversifying the geography of their production plants. They look for reliable manufacturing sites where they can effectively transfer technology, efficiently scale-up manufacturing and ensure quality control of their products. Today, leading pharmaceutical, biotechnology and medical technology companies have invested in more than 50 commercial-scale manufacturing facilities in Singapore.

Rapid set-up & export

Companies setting up in Singapore can construct and validate a manufacturing plant within 24-36 months, given the city-state's quality manpower, world-class infrastructure and reliable supporting services.

In addition, Singapore has established a good track record with regulatory authorities as well as strong trade linkages with major markets. Together with its excellent logistics connectivity, companies can quickly export and distribute their products to global markets.

Pro-business environment

Singapore is well-known for its business-friendly environment, with its good corporate governance, clear and consistent government guidelines, and excellent IP protection. Singapore also offers a politically stable and favourable tax environment.

This ease of doing business is complemented by the country's support for the adoption of environmentally-friendly practices and technologies in the manufacturing sector.

Industry's partner in process development

Companies (e.g. GlaxoSmithKline, Novartis) are extending beyond commercial manufacturing into process development. In addition to setting up their own process development units, companies can also partner our research institutes (e.g. Institute of Chemical Engineering and Sciences, Bioprocessing Technology Institutes) to optimise manufacturing processes and the formulation of new products. The Singapore Institute of Manufacturing Technology has partnered companies to develop automation solutions to streamline operations.

At one glance

- Strong track record in operational excellence and regulatory compliance
- Singapore has acceded to Pharmaceutical Inspection Co-operation Scheme, which will enable companies to export to global markets; Singapore has also signed a Mutual Recognition Agreement with GMP conformity assessment with Australia's Therapeutic Goods Administration.
- S$19 billion in manufacturing output in 2008; manufacturing output grew at a CAGR of 13.2% since 2000.
- 12,450 people were employed in the biomedical sciences manufacturing sector in 2008. Companies can tap into Singapore's base of 350,000 skilled talent in related sectors (chemical, electronics).
- Industry players have collaborated with the National University of Singapore to set up the Singapore Academy for GxP Excellence (SAGE) to promote best practices and train new entrants.

Quality manpower

Singapore offers a base of skilled local talent who are well-trained in science and mathematics. Singapore's workforce is consistently ranked the world's best labour force (BERI). Since the 1970s, the city-state has had zero man-days loss on strikes, due to its tripartite system that brings together the government, employers and unions to address manpower issues harmoniously. Manpower costs remain competitive with entry salaries for B.Eng graduates pegged at US$1,500 each month for about 50 working hours each week.

GlaxoSmithKline was Singapore's first pharmaceutical manufacturer, and has continued to expand its investments in Singapore to S$1.5 billion.

GSK: Moving into manufacturing innovation

GlaxoSmithKline (GSK) and Singapore go way back, with GSK setting up its first manufacturing operations here in 1972. The company has since expanded its presence, with activities that go beyond manufacturing to include drug discovery, clinical research and a regional HQ. To date, GSK's investments in Singapore total at S$1.5 billion.

Recent key manufacturing developments include:

- 2006 — GSK announced its first large vaccine investment in Asia in a manufacturing facility that will produce pediatric vaccines.
- 2008 — A R&D pilot plant, which will carry out process-development and manufacture materials for clinical trials, was opened at GSK's Jurong facility that produces chemical-based active pharmaceutical ingredients.
- Jan 2009 — GSK collaborated with the Bioprocessing Technology Institute (BTI). This aimed to integrate BTI's expertise with GSK's capabilities in biologics, to develop new approaches in vaccine and process development.
- Jan 2009 — An investment of S$100 million to improve the capability and flexibility of production at GSK's Jurong facility.

"The greater business environment has evolved and the challenges that the healthcare industry, payers and government agencies face see them demand for more products of value. Our recent investments such as the R&D Pilot Plant and the announcement of an additional S$100 million to improve the capability and flexibility of one of our production buildings in Singapore will help GlaxoSmithKline face up to the challenges by supporting the seamless development and implementation of new processes from the R&D bench to full-scale manufacturing. The higher level of technology being implemented will also allow more advanced process control supporting the development of more efficient processes."

— Chris Dobson, Vice President & Site Director, Global Manufacturing and Supply, GlaxoSmithKline Singapore

Lonza: A vote of confidence for Singapore

Swiss biologics contract manufacturer, Lonza, is building two commercial-scale mammalian cell-based contract manufacturing facilities in Singapore. Lonza's first contract manufacturing facility has been outsourced to produce Avastin, Genentech's cancer drug. The second US$350 million facility will support the needs of additional customers. When completed, both facilities will have up to four mammalian bioreactor trains, each with a flexible capacity of 1,000 up to 20,000 litres, inclusive of the respective purification units.

"In line with Lonza's strategy to develop its capabilities and expand the biopharmaceuticals business in the fast-growing Asian market, our Singapore facilities mark an important milestone, as Lonza reinforces its leading position as a global custom manufacturer of biopharmaceuticals. The facilities will operate with cutting-edge technology and a skilled labour force and will be able to manufacture products with a wide array of processes, yields and technologies."
— Stephan Kutzer, Head of Lonza Biopharmaceuticals

Companies in Singapore

Leading pharmaceutical and biotechnology companies that have invested in manufacturing facilities in Singapore include:

- Abbott
- Alcon
- Baxter
- Genentech
- GlaxoSmithKline
- Lonza
- Merck Sharp & Dohme
- Novartis
- Pfizer
- Sanofi-Aventis
- Schering-Plough
- Wyeth

Tuas Biomedical Park

- 360 hectares of prepared industrial land for biopharmaceutical manufacturing
- Ready infrastructure reduces lead time for ramp up
  - Stable water supply, electricity, telecommunications lines
  - Sewerage discharge
  - Efficient road access and ease of transportation
- Flexible land payment options
- Free from natural disasters

Edwards Lifesciences: Manufacturing heart valves in Singapore

Edwards Lifesciences has located its first Asia-Pacific heart valve manufacturing facility in Singapore. The 98,000 square foot facility will produce Edwards' flagship product, the Carpentier-Edwards PERIMOUNT tissue heart valve replacements. This facility will also house the company's regional headquarters.

"For our business, we require a talented and skilled workforce, strong infrastructure, government support, favourable business climate and protection. I am pleased to say that we found all of these in Singapore."
— Donald Bobo Jr, Corporate Vice President, Heart Valve Therapy, Edwards Lifesciences

Edwards Lifesciences' Singapore facility will be part of the company's global network of advanced heart valve operations in Irvine (California, U.S.) and Horw (Switzerland). The facility will also enable the company to access the fast-growing Asia-Pacific market.

Illumina: Set up key global site for micro-array

Illumina has set up its first Asian manufacturing plant in Singapore, which will also be the company's key global site. The plant has the capacity to produce over 40,000 micro-arrays each quarter, and is intended to mirror production in the U.S., thereby giving the company greater flexibility in manufacturing and production.

"Singapore has a very cosmopolitan community, highly-educated workforce and the ability to do business in Asia in a very friendly way."
— Joel McComb, Senior Vice President, Life Science Business, Illumina (in an interview with Channel NewsAsia, February 2009)

Companies in Singapore

Global medical technology companies that have manufacturing operations in Singapore include:

- Affymetrix
- Baxter
- Becton Dickinson
- Bio-Rad Laboratories
- Biosensors International
- Clearlab
- CIBA Vision
- Edwards Lifesciences
- Hoya
- JMS
- Illumina
- Life Technologies (formerly Applied Biosystems)
- Siemens Medical Instruments
- Waters
- West Pharmaceutical

Start-ups in Singapore

With its strong IP protection, availability of grants and funding, and access to regional and global markets, Singapore is the ideal location for any "bio-preneur" looking to start up and grow a company.

S*BIO: Gaining global recognition

S*BIO is Singapore's first fully-integrated drug discovery company that focuses on research and clinical development of novel targeted small molecule anti-cancer drugs. Established in the year 2000 by EDB Investments' Bio*One Capital, its other investors include Aravis Ventures, Novartis Bioventures and other international funds. In 2008, S*BIO received orphan drug designation from the U.S. FDA for its JAK2 inhibitor, SB1518, for the treatment of myeloproliferative disorders. In January 2009, S*BIO put Singapore on the global map, by entering into two separate licence agreements totalling almost S$1 billion with Onyx Pharmaceuticals Inc and Tragara Pharmaceuticals, to develop and commercialise its compounds.

FORMA: Locating its global research site in Singapore

Singapore is one of the three global research sites for FORMA Therapeutics, a Bio*One portfolio company that was founded by leading researchers from the Broad Institute of Harvard and MIT. The company seeks to integrate important new advances in biology and chemistry, to unlock essential oncology targets that have been elusive to the best scientists in the industry. It currently has drug discovery partnerships with major pharmaceutical and biotechnology players such as Novartis and Cubist Pharmaceuticals. In March 2009, FORMA Therapeutics announced its collaboration with the Experimental Therapeutics Centre of Singapore (ETC), which will leverage FORMA's transformative chemistry platform to discover novel compounds for further development by ETC.

Curiox: Revolutionising research

After winning the Start-Up@Singapore business plan competition in 2007, a team of researchers from the Institute of Bioengineering and Nanotechnology (IBN) spun off Curiox Biosystems. Curiox is headed by researcher-cum-entrepreneur, Dr Kim Namyong, who was the project leader at the IBN research team. Their DropArray™ technology is a unique miniaturisation platform that allows researchers to conduct bioassays faster and cheaper, while maintaining the same level of convenience and flexibility. Incubated by Exploit Technologies, Curiox has attracted investments from Nanostart AG and entered a sales partnership agreement with Seoul-based BioBud, completing both achievements within its first year of operation.

Fetal Genetix: Proof-of-concept grants aid technology commercialisation

NUS spin-off company, Fetal Genetix, was awarded S$250,000 from SPRING Singapore's Technology Enterprise Commercialisation Scheme. This grant will be used to develop a novel, non-invasive prenatal screening test for alpha-thalassaemia. Successful completion of the proof-of-concept will bring Fetal Genetix one step closer to helping expectant mothers.

Biosensors International: Listed in Singapore, marketed globally

Biosensors International started in 1990, as a contract manufacturing company for critical care products. The company now develops, manufactures and commercialises innovative medical devices used in interventional cardiology and critical care procedures. Biosensors is rapidly emerging as a leader in drug-eluting stents. It is listed on the Singapore Stock Exchange and has presence in the US, across Europe and Asia. In 2006, Biosensors was identified by the US Medical Device and Diagnostic Industry publication as one of the 50 medical technology companies to watch, given its innovative biodegradable-polymer drug-eluting stents.

Home for Global Talents

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

Smart move to Singapore

"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 here, with its international community and the multi-cultural aspects. There is a buzz here - the world is looking at Singapore and knocking on our door to find out more about what we are doing."
— Prof Edward Holmes, who moved to Singapore in 2006, with wife Judith Swain. Prof Holmes is the Deputy Chairman of A*STAR's Biomedical Research Council, while Prof Swain heads the Singapore Institute for Clinical Sciences.

Food, culture and trekking

"The transition from Europe to Singapore was surprisingly easy. People are bending over backwards to facilitate the process and you feel immediately welcome. I have always been an Asia lover, and I'm fascinated by the tremendous variety and diversity in landscapes, ethnicities, food and cultural life. I have well adapted to the climate and enjoy the friendliness of people. I try to travel a lot, discovering new landscapes, plant and animal life. As an avid trekker, I am equally interested in the cultural and religious heritage of indigenous people, and have a special interest in medicinal plants."
— Dr Alex Matter, who moved to Singapore in 2003, to head the Novartis Institute for Tropical Disease (NITD). In 2009, he took over the helm of Experimental Therapeutics Centre.

Loving Singapore

"I visited Singapore a few times between 2005 to 2007 for holidays, and found it an amazing country. I moved here with my family in 2008 to work with Lilly, as it was a good career opportunity for me and a great experience for my wife and daughter. My family has adapted to Singapore very well, interacting with Chinese, Malay and Indian families. I do love living here. Singapore is a beautiful environment."
— Dr Lavleen Kumar Gupta, who is a group leader at the Lilly Singapore Centre for Drug Discovery.

Safety and security

"I moved to Singapore around 2007 and it was very easy for my family and me to adapt to our lifestyle here. 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 safe security in Singapore. I allow my young children to commute around independently - something I would never allow outside Singapore. It is also a great place to enjoy the variety of food, infrastructure and multi-racial society. As Singapore is a centralised location in Asia, I take regional vacations, whenever the opportunity arises."
— Mr Vincent Hingot, who is the site director at GlaxoSmithKline Biologicals.

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

Singapore's Integrated Biomedical Sciences Initiative

The Singapore government is committed to develop the biomedical sciences sector, and adopts an integrated approach across key agencies.

Businesses

- 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 to grow the Singapore economy. We dream, design and deliver solutions that create value for investors and companies in Singapore. In so doing, we attract economic opportunities and jobs for the people of Singapore, and help shape our country's economic future. [www.sedb.com | www.biomed-singapore.com]
- Bio*One Capital is a subsidiary of EDB Investments and is a leading biomedical sciences dedicated investment management company in Asia, with a portfolio of over 50 companies internationally. Bio*One invests in biotechnology, specialty pharmaceuticals, medical technology and healthcare delivery companies worldwide. [www.bio1capital.com]

Academia

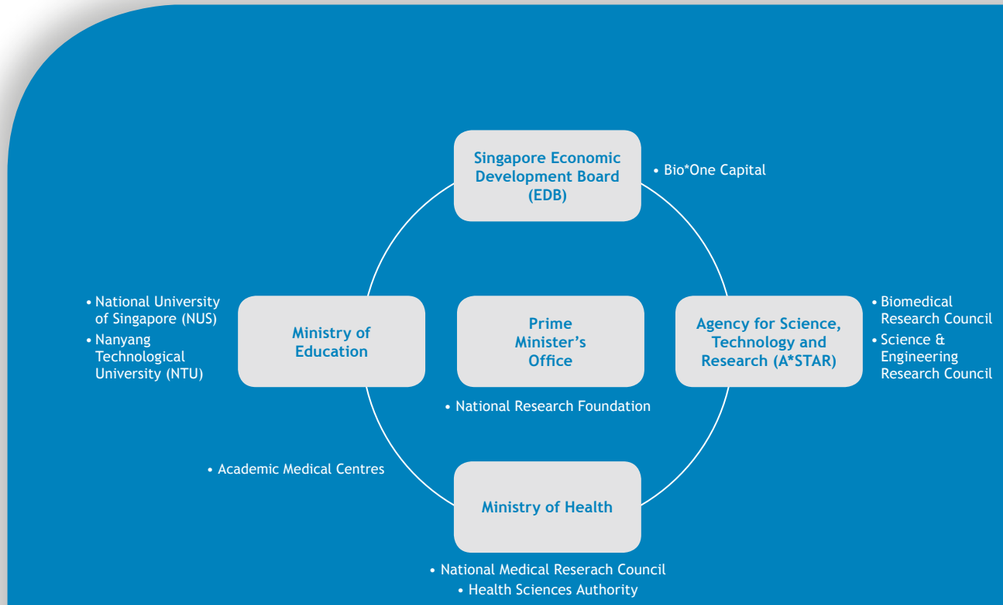
- National University of Singapore (NUS) is well-known for its research strengths in engineering, life sciences and biomedicine, social sciences and natural sciences. Integrating its core competencies of education and research with an entrepreneurial dimension, NUS strives to create a supportive and innovative environment to promote creative enterprise within its community. [www.nus.edu.sg]
- Nanyang Technological University (NTU) is a research-intensive university with globally acknowledged strengths in science and engineering. NTU's international outreach is broad and strong, and includes academic and research partnerships with more than 400 institutions in about 45 countries. [www.ntu.edu.sg]
- Academic Medical Centres are located at both Kent Ridge and Outram Campuses, where these investigational medicine units provide facilities to conduct early phase clinical trials, including proof-of-concept, Phase 1 (including first-in-man) and Phase 2a clinical trials for novel drugs and diagnostics, research on biomarkers and disease mechanisms, as well as bio-imaging studies.

Research

- National Research Foundation (NRF) is a department under the Prime Minister's Office that sets the national direction for research and development to transform Singapore into a knowledge-intensive, innovative and entrepreneurial economy. A five-year budget of S$5 billion has been allocated to the NRF in 2006 to achieve its objectives. [www.nrf.gov.sg]
- Biomedical Research Council (BMRC) is part of Singapore's lead public-sector research agency - Agency for Science, Technology and Research (A*STAR). BMRC develops core research capabilities in biomedical sciences research units and provides grant support for public-sector research. BMRC also actively promotes translational medicine and cross-disciplinary research. [www.a-star.edu.sg]
- National Medical Research Council (NMRC) was appointed by the Minister for Health with a mandate to lead, promote, coordinate and fund medical research in Singapore. It is also responsible for the development of clinician-scientists through awards and fellowships. [www.nmrc.gov.sg]
- Bioethics Advisory Committee (BAC) addresses the ethical, legal and social issues arising from biomedical sciences research in Singapore. [www.bioethics-singapore.org]
- Genetic Modification Advisory Committee (GMAC) oversees and provides scientifically-sound advice on the research and development, production, release, use and handling of genetically modified organisms in Singapore. [www.gmac.gov.sg]

Regulation

- Health Sciences Authority (HSA) is a statutory board of the Ministry of Health that applies medical, pharmaceutical and scientific expertise through its professional groups, to protect and advance national health and safety. HSA also serves as the national regulator for health products, ensuring they are wisely regulated to meet standards of safety, quality and efficacy. [www.hsa.gov.sg]



Bax-beta pathways on the cover page are adapted from a draft of V.C. Yu (2009)'s model. Yu is a principal investigator at Singapore's Institute of Molecular and Cell Biology.