
Singapore's biomedical sciences landscape

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was appointed Executive Director of the Economic Development Board's Biomedical Sciences Cluster on 1st March, 2007. Biomedical Sciences covers Pharmaceuticals, Biotechnology, Medical Technology and Healthcare Services. Keat Chuan is a Glaxo-EDB scholar who graduated with a Master of Engineering (Chemical Engineering), from Imperial College of Science, Technology & Medicine, University of London. Keat Chuan also attended Stanford University's Graduate School of Business and graduated as a Sloan Fellow in July 2004. He spent seven years based in the US as Centre Director (Washington, DC) and Regional Director (Eastern US) of the Economic Development Board's Global Operations.

Abstract

Singapore's vision is to be the Biopolis of Asia, a leading international biomedical sciences cluster advancing human health, through the pursuit of excellence in research and development, manufacturing and healthcare delivery. To achieve this, Singapore has built up world-class capabilities across the entire value chain from drug discovery, development and clinical research, to manufacturing and healthcare delivery. In the year 2000, Singapore's Biomedical Sciences (BMS) initiative was launched to establish a focused effort on the development of this sector as the fourth pillar of Singapore's industry cluster, alongside electronics, chemicals and engineering. The BMS initiative covers the Pharmaceutical, Biotechnology, Medical Engineering and Technology and Healthcare Services industries. An integrated strategy was adopted for the development of the BMS sector, focusing on Human Capital, Intellectual Capital and Industrial Capital, or 3 Cs in short. The first phase of the BMS initiative (2000–2005) put in place key building blocks by establishing core capabilities in biomedical research, and introducing important human capital and industrial capital development initiatives. For the next phase (2006–2010), we will build on this foundation and strengthen our capabilities in translational and clinical research to bring discoveries from the bench to the bedside and the marketplace, and ultimately improve human healthcare.

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INTRODUCTION

Singapore offers unlimited opportunities for Biomedical Sciences (BMS) companies. Strong government support and a pro-business environment have attracted industry leaders such as Abbott, Aventis, Affymetrix, Baxter, Becton-Dickinson, Eli Lilly, Genentech,

GlaxoSmithKline, Lonza, Merck & Co, Novartis, Pfizer, Schering-Plough, Siemens and Wyeth to Singapore for manufacturing and R&D activities.

The three groups that are involved in Singapore's BMS initiative are the Biomedical Sciences Group (BSMG) of the Economic Development Board (EDB), Bio*One Capital of the EDB and the Biomedical Research Council (BMRC) of the Agency for Science, Technology & Research (A*STAR). BMSG is responsible for industry development, Bio*One Capital makes strategic investments

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in companies that lead to economic spin offs for Singapore, while BMRC takes the lead in coordinating and funding public sector and academic research, as well as supporting the development of human capital.

The BMS industry did exceptionally well in 2006 (Figure 1). The manufacturing output grew strongly to S\$23bn in 2006, an unprecedented 30 per cent increase over 2005. Within a short span of six years, the manufacturing output has grown almost fourfold from the year 2000. Pharmaceuticals account for 91 per cent of the total output while Medical Technology maintained its output levels at over S\$2bn. Employment expanded by 4 per cent to reach 10,571. Of the total jobs in the BMS manufacturing sector, 62 per cent are in the Medical Technology sector. The target is for Singapore's BMS industry to reach S\$25bn in manufacturing output and an employment of 15,000 by 2015.

MANUFACTURING AND R&D

There are now close to 45 pharmaceutical, biotechnology and medical devices manufacturing plants in Singapore. There are also over 30 companies with R&D operations here.

Some examples of companies with significant operations are provided below.

In 1994, Schering-Plough became the first US pharmaceutical corporation to establish manufacturing operations in Singapore. Over the next 12 years, the company continued to expand its operations across the value chain. Today, Schering-Plough is Singapore's largest pharmaceutical investor and employer, with a fixed asset investment exceeding US\$1bn. Building on its base of seven manufacturing plants in Singapore, the company has the most comprehensive pharmaceutical manufacturing profile in the country. The products made in Singapore include active drug substances, tablets, dry powder inhalers, sterile injectables and nasal sprays. Apart from manufacturing, Schering-Plough's Asia-Pacific headquarters is also located in Singapore to coordinate and direct marketing, sales and business activities for its subsidiaries in more than 12 countries.

Lilly's US\$150mn expansion of its corporate research lab in 2007 will triple the size of its operations in Singapore to 150 scientists at steady state. The Lilly-Singapore Centre for Drug Discovery will focus on drug discovery work for cancer and metabolic diseases, while concurrently serving as Lilly's centre of excellence for disease state modelling and computational sciences.

Siemens Medical Instruments (SMI) in Singapore is the worldwide manufacturing

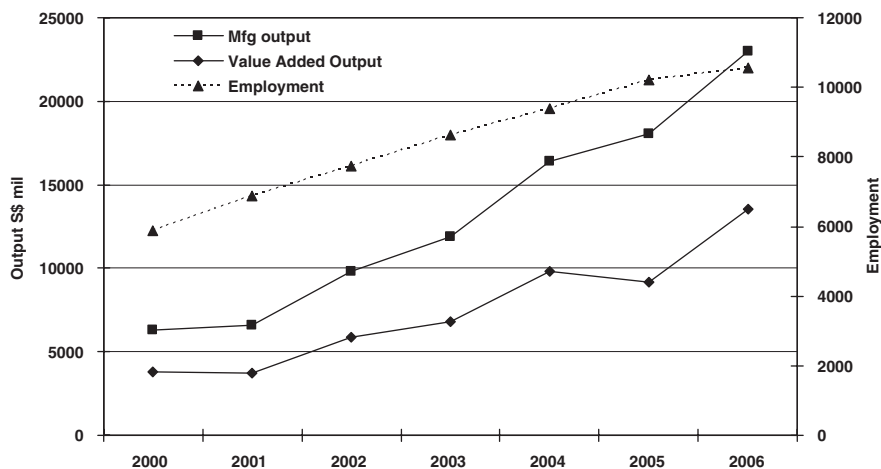


Figure 1: BMS industry figures in Singapore

and logistics headquarters for Erlangen-based parent company, Siemens Audiologische Technik GmbH. It produces close to a fifth of the world's hearing aids. SMI is also investing in R&D capabilities to develop a new generation of products, such as the state-of-the-art 'Triano 3', the first digital hearing system in the world that is equipped with three microphones, which will allow users to understand speech even in very noisy environments.

Scheduled for completion in October 2007, Edwards Lifesciences' manufacturing plant will be the company's third global manufacturing facility dedicated to producing Edwards' world-leading Carpentier-Edwards PERIMOUNT replacement tissue heart valves. The 98,000 square foot facility will employ up to 500 people when operating at full capacity.

Having established a reputation as the most competitive and trusted site for pharmaceutical bulk activities, secondary manufacturing and medical technology, Singapore is now aggressively pursuing investments in biologics, an area that will drive growth in the drug industry. The country is quickly building critical mass for biologics manufacturing and expects to maintain this momentum as it continues to attract new investments in this area. In less than two years, Singapore has brought in five major biologics investments totalling over US\$1.5bn. These include two plants by Lonza, one by Genentech, one by GSK Biologicals and one by Novartis. Biologics drugs represent a tremendous growth opportunity for Singapore. A significant proportion of the pharmaceuticals and biotechnology industries' future growth is expected to be driven by biologic drugs.

CLINICAL RESEARCH

Apart from manufacturing and R&D, many of the world's leading clinical research organisations (CROs) have established operations in Singapore. These companies not only work with Singapore hospitals to conduct scientifically demanding trials, they

have also set up their regional hubs in Singapore to manage clinical development activities in the region. Examples include Quintiles, Covance, ICON, MDS Pharma, PPD and Gleneagles Clinical Research Centre.

Many public sector hospitals and speciality centres in Singapore are involved in clinical trials including Singapore General Hospital, National University Hospital, KK's Women's and Children's Hospital, Changi General Hospital, Tan Tock Seng, Alexandra Hospital, National Cancer Centre, Singapore National Eye Centre, National Heart Centre, National Dental Centre, National Neuroscience Institute and National Skin Centre.

Likewise, a significant number of pharmaceutical companies including AstraZeneca, Bristol-Myers Squibb, GlaxoSmithKline, Novartis, Novo Nordisk, Sanofi-Aventis and Schering-Plough have set up their clinical trials coordination centres in Singapore. Two companies, Lilly and Pfizer, also have their own dedicated Phase I clinical trial units in Singapore.

Undertaking clinical trials is a complex, lengthy and expensive process. It may involve organising multi-centre trials, dealing with hundreds or thousands of participants and extensive documentation, while at the same time, maintaining strict international standards of ethics and scientific excellence.

A total of 217 clinical trials were conducted in Singapore in 2006,¹ of which 116 were phase III and 18 were phase IV studies (Figure 2), while in terms of therapeutic area, oncology and clinical pharmacology studies form close to 50 per cent of the trials conducted (Figure 3).

INFRASTRUCTURE

R&D

In 2003, Singapore opened the Biopolis (Figure 4), an integrated R&D complex with two million square feet of space that houses nine public research institutes as well as R&D laboratories of pharmaceutical and

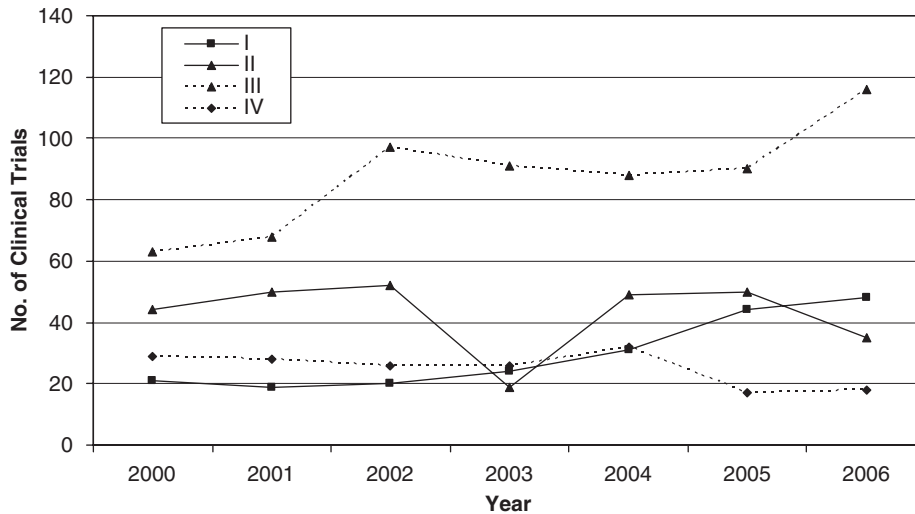


Figure 2: Number of clinical trials by phases (Source: Health Sciences Authority (HSA))

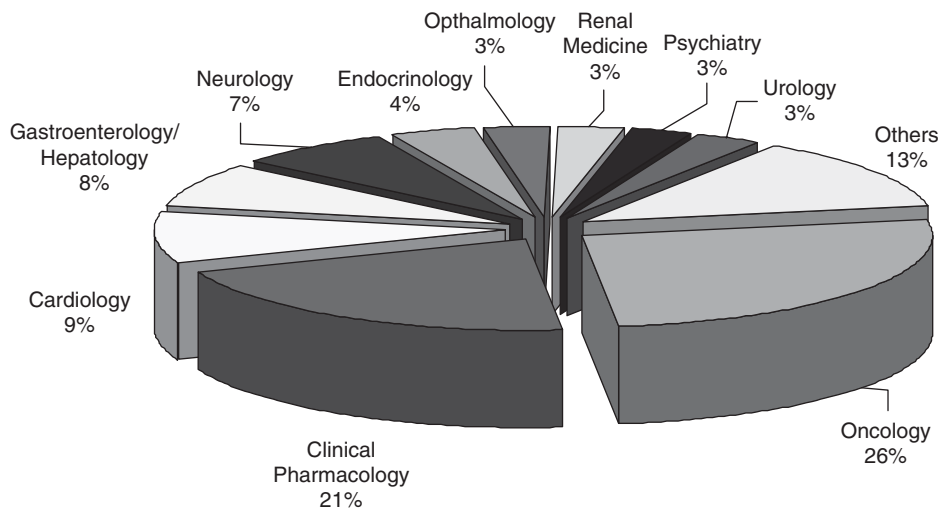


Figure 3: Therapeutic areas for clinical trials (N=152) (Source: HSA)

biotechnology companies. By co-locating private and public sector research, the Biopolis provides common infrastructure such as research facilities, equipment and amenities, thus encouraging the synergy of scientific ideas, facilitating cross-disciplinary collaborative research and lowering the entry barrier for companies to set up operations here. The shared scientific equipment includes X-ray crystallography, nuclear magnetic

resonance, electron microscopy, 9.4T MRI machine, DNA sequencing, a research facility with specific pathogen-free research animals and other facilities. Companies can also leverage on shared infrastructure such as conference facilities and meeting rooms.

Some of the public research institutes at the Biopolis include the Bioinformatics Institute, Bioprocessing Technology Institute, Centre for Molecular Medicine, Genome Institute of



Figure 4: The Biopolis R&D complex

Singapore, Institute of Chemical and Engineering Sciences (ICES) Chemical Synthesis Lab, Institute of Molecular & Cell Biology, and Institute of Bioengineering & Nanotechnology. Some of the private sector tenants with research operations at Biopolis include the Novartis Institute for Tropical Diseases, Takeda Singapore, GlaxoSmithKline Centre for Research in Cognitive and Degenerative Disorders, Waseda-Olympus

Bioscience Research Institute and ES Cell International. In addition to the private sector, the Singapore Health Sciences Authority, a local regulatory agency for healthcare sciences and services in Singapore, as well as the Regional Emerging Diseases Intervention Centre, an entity established jointly by Singapore's Ministry of Health and the Communicable Disease Centre (CDC) and National Institute of

Health (NIH) in the US, are also based at the Biopolis.

The take-up rate for Biopolis Phase I exceeded initial expectations, achieving full occupancy a mere one year after it was opened. Development plans for Biopolis Phase II was thus accelerated. Phase II, which was opened in October 2006 and provides an additional 400,000 square feet of space, is now over 80% occupied. Work has already begun on Phase III of the Biopolis which is expected to add another 420,000 square feet when ready in 2009.

Manufacturing

The Tuas Biomedical Park (TBP) plays an instrumental role in attracting global biopharmaceutical manufacturing activities to Singapore. TBP had been developed as a 'plug and play' environment for manufacturing operations, providing ready access to essential infrastructure such as roads, drainage systems, power and water supply, as well as telecommunication lines. Manufacturers can also leverage on third-party utilities and services such as steam, natural gas, chilled water and waste treatment. TBP currently occupies a land area of over 370 hectares and is home to the following leading biopharmaceutical and medical technology companies: Abbott, CIBA Vision, Genentech, GSK Biologicals, Lonza, Merck Sharp & Dohme, Novartis, Pfizer and Wyeth.

Two state-of-the-art trigeneration facilities are being built for Pfizer and Schering-Plough. Trigeneration produces three types of utilities – electricity, steam and chilled water from a single integrated system. Compared to the conventional methods, Pfizer's trigeneration system raises heat utilisation to 83 per cent from 59 per cent and reduces carbon dioxide emissions by about 17 per cent. These translate into greater energy efficiency and projected annual energy cost savings of over US\$650,000. This environmentally friendly plant will be designed, built and operated by TPGS Green

Energy, a joint venture between Tuas Power and Gas Supply. When completed by mid-2008, Schering-Plough's new facility will support the utility needs of its biotechnology and pharmaceutical plants and is expected to help the company reduce its carbon dioxide emission by 24 per cent yearly.

VENTURE FUNDING

In addition to tax incentives, research and training grants, companies setting up operations in Singapore can also explore investment funding options to support the different stages of their development. In addition, companies can look to Singapore to raise equity financing through venture capital (VC) or listing in the public market.

One of the VCs focused on BMS investments is Bio*One Capital, a subsidiary of the EDB. Bio*One Capital manages four dedicated BMS funds totalling over US\$700m – Biomedical Sciences Investment Fund (BMSIF), PharmBio Growth Fund, Life Sciences Investment Funds and Singapore Bio-Innovations Fund.

Bio*One also administers the Biomedical Sciences Innovate 'N' Create Scheme (BMS INC) that was set up to support local biomedical start-ups. This scheme provides seed and early stage funding, and aims to foster the BMS entrepreneurial environment in Singapore. Successful ventures will receive investments of between S\$250,000 to S\$2,000,000 in the form of equity or convertible loans.

The Start-up Enterprise Development Scheme (SEEDS) Capital is subsidiary of SPRING Singapore. SEEDS provides innovative Singapore-based start-ups with matching funds up to S\$300,000.

MANPOWER

Talent is key to this industry. A*STAR has embarked on an aggressive programme to attract more Singaporeans to pursue graduate studies locally as well as in top universities

around the world. Since 2001, close to 500 people have received scholarships and fellowships to pursue BMS-related studies. By year 2010, more than 1,000 Singaporean PhDs would be added to the research community.

To complement the training of local Singaporeans, Singapore welcomes international talent from all around the world. Good science, a cosmopolitan environment, and flexible immigration policies are some reasons why many international researchers find Singapore attractive. The following are some prominent personalities in Singapore's research community:

- Dr Edison Liu, former director of clinical sciences at the US National Cancer Institute, is Executive Director of Genome Institute of Singapore.
- Dr Axel Ullrich, while heading the molecular biology department at Max Planck Institute, is also with the Singapore Onco Genome Laboratory.
- Dr Alan Colman, formerly from UK-based PPL Therapeutics, is Executive Director, Singapore Stem Cell Consortium (SSCC).
- Dr Yoshi Ito, from the University of Kyoto in Japan, is Principal Investigator at the Institute of Molecular & Cell Biology.
- Dr Sir David Lane, from the University of Dundee, is the Executive Director of the Institute of Molecular and Cell Biology.
- Dr Edward Holmes, from the University of California San Diego (UCSD), is the Executive Deputy Chairman, Clinical-Translational Sciences at A*STAR's BMRC.
- Dr Judith Swain, from the University of California San Diego (UCSD), is the Executive Director, Singapore Institute of Clinical Sciences (SICS).
- Drs Neal Copeland and Nancy Jenkins, from the National Cancer Institute, are

Principal Investigators, at A*STAR's Institute of Molecular and Cell Biology (IMCB).

SINGAPORE'S CRITICAL SUCCESS FACTORS

There are many reasons why companies are setting up substantial operations in Singapore. These include:

- strong intellectual property rights protection and enforcement;
- skilled manpower;
- stable economy;
- strong government commitment and support;
- Singapore's strategic geographic location provides easy access to the fast growing Asia Pacific market;
- excellent IT and logistics infrastructure;
- favourable tax incentives;
- Singapore's growing network of Free Trade Agreements with key markets including the US and Japan;
- excellent regulatory support and conducive infrastructure;
- the presence of world-class research institutes and hospitals.

LOOKING AHEAD

The first phase of the BMS initiative (2000–2005) put in place key building blocks by establishing core capabilities in biomedical research, and introducing important human capital and industrial capital development initiatives. For the next phase (2006–2010), we will build on this foundation and strengthen our capabilities in translational and clinical research to bring discoveries from the bench to the bedside and the marketplace, and ultimately improve human healthcare.

Singapore is now aggressively pursuing investments in biologics, an area that will drive growth in the drug industry. Singapore will also continue a focused effort to grow the Medical Technology sector in the areas of

Cardiovascular, Vision, Diagnostic and Imaging, and Research Tools and Scientific Instruments by leveraging on Singapore's strengths in electronics and precision engineering as well as physical sciences research capabilities. Similarly, we aim to further expand the industry R&D base, and

increase the number of companies undertaking the discovery and development of new drugs and medical devices in Singapore.

Reference

1. http://www.hsa.gov.sg/publish/hsaportal/en/health_products_regulation/clinical_trials/statistics.html.