

biotech focus

Big dreams, small island—the prospects of Taiwan's biotech economy

Govindasamy Agoramoorthy, agoram@mail.tajen.edu.tw and Minna J. Hsu, hsumin@mail.nsysu.edu.tw

More than a century ago, British naturalist Alfred Russel Wallace was impressed by the beauty of Taiwan and he wrote, "Among recent continental islands there is probably none that surpasses in interest and instructiveness the Chinese island named by the Portuguese 'Formosa'" [1]. Taiwan (area 36 000 km²; [Figure 1](#)) lies on the Tropic of Cancer and is separated from China by a narrow strait, which is only 130 km wide at its narrowest. It harbors a population of 23 million and over the past few decades, this tiny island has evolved from agricultural backwater to global technological giant.

Taiwan reverted to Chinese control after World War II. Following the Communist victory of the Chinese Civil War in 1949, two million Kuomintang nationalists fled to Taiwan and established an authoritarian government claiming sovereignty over China and Greater Mongolia. Over the next five decades, the ruling authorities gradually democratized. Taiwan underwent its first peaceful and democratic transfer of power in 2000, from the nationalist Kuomintang Party to the Democratic Progressive Party. Throughout this period, Taiwan prospered and became one of East Asia's 'Economic Tigers' and now in an advanced position economically and technically to assist developing nations globally [2]. The dominant political issues continue to be the relationship between Taiwan and China – specifically the question of unification – as well as political and economic reforms. Over the past two decades, Taiwan has concentrated mainly

on the development of high-tech industries such as electronics, information technology, computer and semiconductors. Now it aims to repeat the innovative success and global standing by revolutionizing the biotechnology industry.

Recent biotech output and strategies

Taiwan's fledgling biotech industry had a production value of US\$ 4.8 billion in 2005. Between 2003 and 2005, the revenue generated by the biotech industry increased by 46.4%, especially that from pharmaceuticals, which increased by 475% in export value ([Table 1](#)). Similarly, the import value also stepped up for pharmaceuticals by 94.9%. The number of biotech companies multiplied significantly by 53.3%, and the production of medical appliances rose 27.4% during the same period ([Figure 2](#)). The R&D manpower in biotechnology doubled during 2003–2005 when compared with 2002 ([Figure 3](#)). The above statistics clearly demonstrate the boom of biotech industry in Taiwan. To further stimulate the biotech endeavor, the government alone aims to invest US\$ 4.5 billion by 2010 as part of the Promotion Plan for the biotech industry, which is equivalent to India's projected biotech investment [3].

The ambitious guidelines set forth by the governmental Promotion Plan for the biotech industry serve as a road map with specific goals and actions to succeed in the biotech endeavor. The document was first released by the cabinet, the Executive Yuan, in 1995 and has since been

updated biannually [4]. The main focus of the plan is to strengthen five crucial components of the biotech industry: R&D, law and regulations, technology transfer and commercialization, investment promotion and international cooperation, and marketing and services [4]. Taiwan is determined to lead Asia in genomic research, human clinical trials, and subtropical floriculture supported by a vibrant and biotech-focused capital economy.

Taiwan's leading research institute, Academia Sinica located in Taipei is a member of the International Rice Genome Sequencing Project. Other genomes to be sequenced include various varieties of bacteria, plant/human pathogens, mosquitoes, and mushrooms at the Academia Sinica. Industrial cities such as Taipei, Hsinchu, and Kaohsiung have world-class medical and research facilities. The Hsinchu, science-based industrial park, is Taiwan's equivalent of the Silicon Valley. The park is close to National Tsinghua University, National Chiao Tung University and Industrial Technology Research Institute. These institutions support the park with skilled manpower and machineries including the scientific 'know-how'—the same way Stanford University and University of California-Berkeley aid Silicon Valley.

Taiwan's pharmaceutical industry has always included the Chinese herbal medicine industry. The knowledge and experience in Chinese herbal medicine goes back hundreds of years, and Taiwan is modernizing its herbal medicine industry by involving institutes such as Biomedical Engineering Center, Development Center for Biotechnology, and Pharmaceutical Industries Technology Development Center to stimulate new drug development.

The Council of Agriculture, which is equivalent to the federal Ministry of Agriculture is currently assisting county-level agencies to establish agro-

**FIGURE 1**

A map of Taiwan.

biotech parks such as National Flower Park in Changhua county, Taiwan Orchid Plantation in Tainan county, Special Herb Biotechnology Park in Chiayi county, and Marine Biotechnology Park in Ilan county; these parks are under construction in the countryside. These new agro-biotech parks will become satellite-farming zones and are estimated to generate US\$ 1 billion by 2012 through crops, medicinal herbs, flowers, orchids, and marine products using biotechnology [5]. Such development will certainly supplement local farmers' income.

Legal boost to draw foreign firms

A well-defined legal framework is a basic requirement for a business environment where the biotech industry can prosper. This was the

reason that in July 2007, Taiwan enacted the Statute for Biotechnology and New Medicine Industry Development to encourage private sector involvement in biotech projects [3]. The new law will also benefit R&D based local firms, as their overseas biotech suppliers will be allowed tax-free investment. For example, the company TaiGen Biotech, which focuses on cancer and diabetes drugs, will save large amounts of money by clinically testing new drugs overseas, which will be tax-free. Also, the tax incentives will help to attract new capital for biotech firms. Many firms including Taiwan's two leading manufacturing conglomerates, Formosa Plastics and Hon Hai Group, have already started to invest in Taiwan's biotech market. As a result of tax incentives, Formosa Plastics has founded

'Formosa Biomedical Technology', which produces diagnostics, health foods, cosmetics, and functional textiles.

Challenges and solutions

Despite Taiwan's aggressive approach to boost biotech growth, strong regional and international competition needs to be considered. Taiwan's population is roughly one-fifth of that of Japan and one-tenth of that of the USA. Owing to its small size and short history in high-tech industry, Taiwan needs creative approaches to deal with the global competition. One way to do this is to emphasize international teamwork to minimize competition, and maximize growth.

Recruiting top notch scientists is often a question of finding overseas Taiwanese who want to help their native land. This overseas community, which includes Yuan T Lee, a Nobel laureate, has provided a crucial link for information, cooperation, and business ventures in the past. In recent years, less Taiwanese graduate students have moved to the West leaving a smaller pool of expatriates' reserve for the market. To encourage the recruitment of skilled foreign scientists, the Taiwanese government has recently relaxed immigration policy. Hundreds of post-doctoral fellows are now working in Taiwan's biotech firms and research labs, many from India [6]. Moreover, efforts are underway to improve graduate level education at local universities, but an increasing unemployment rate and low salaries are not conducive for scientists to consider a career in science. Graduates in Hong Kong and Singapore earn more than in Taiwan, and salaries for scientists and professors in universities have been stagnant for years. This problem will need to be addressed if Taiwan wants to maintain its competitive edge in biotechnology.

Government corruption in recent years has created an unpleasant atmosphere for Taiwan's biotech industry. Taiwan's Ministry of Justice

TABLE 1

Current Status of biotechnology development in Taiwan (2003-2005)

	Biotechnology			Pharmaceutical			Medical appliances			Total	
Year	2003	2004	2005	2003	2004	2005	2003	2004	2005	2004	2005
Revenue	748.5	1039.4	1169.7	1615.2	1824.2	1890.9	948.5	1527.3	1787.9	4390.9	4848.5
Export value	239.4	415.2	463.6	60.6	139.4	348.5	657.6	739.4	818.2	1293.9	1630.3
Import value	357.6	454.5	487.9	897.0	1318.2	1748.5	1224.2	1133.3	1197.0	2478.8	3433.3
Domestic market demand	718.2	1078.8	1193.9	2454.5	3003.0	3290.9	1515.2	1921.2	2166.7	6003.0	6651.5

All value units in US\$ millions (US\$1 = NT\$33).

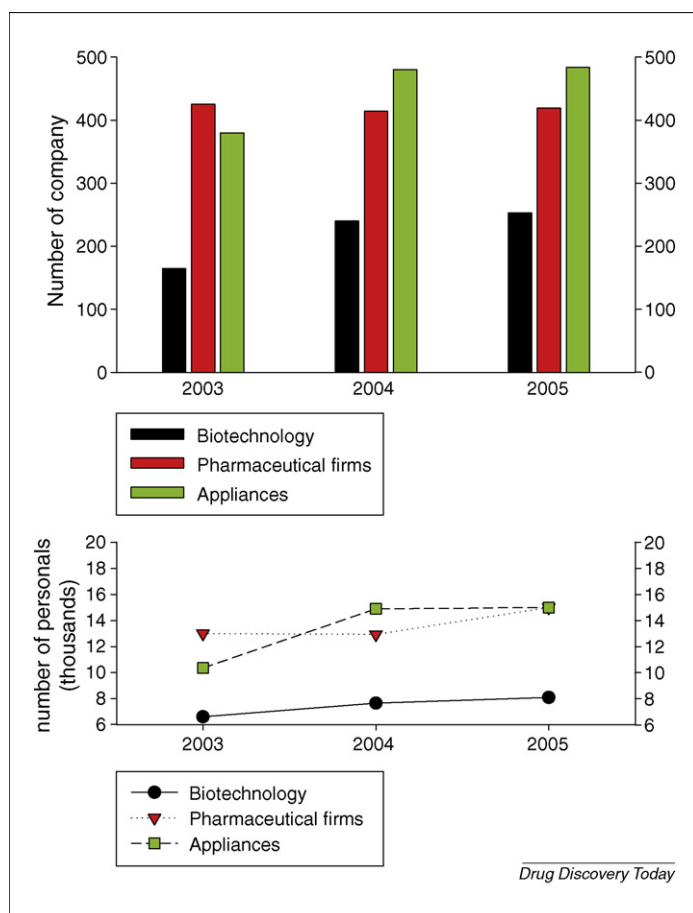
Government web sites with links to Taiwan's biotech companies.

Ministry of Economic Affairs (www.moea.gov.tw).

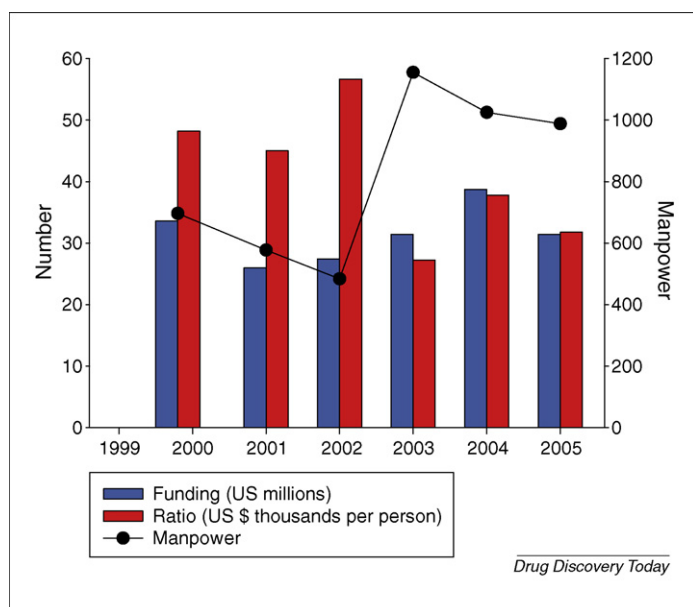
Industrial Development Bureau (www.moeaidb.gov.tw).

Industrial Technology Research Institute (www.itri.org.tw).

Taiwan Government Information Office (www.gio.gov.tw).

**FIGURE 2**

The number of manufacturing companies (biotechnology, pharmaceutical and medical appliances) and size of work force personnel changes between 2003 and 2005 in Taiwan (data pooled from Taiwan Ministry of Economic Affairs).

**FIGURE 3**

Biotech R&D project funding and manpower between 2000 and 2005 (data pooled from Taiwan Ministry of Economic Affairs). Notes: Funding was given as budget numbers. Due to adjustment to the new fiscal year (January–December), the values referred to the period from 1 July 1999 to 31 December 2000.

recovered US\$ 865 million embezzled by local politicians and administrators and prosecuted 3241 cases involving 7959 civil servants and elected officials mainly for taking bribes [7]. Moreover, the wife and son-in-law of Taiwan's President Chen Shui-bian have been implicated in corruption cases triggering street protests that paralyzed Taipei city late past year with citizens demanding the resignation of the President alleging high-level corruption. However, it is hoped that the forthcoming general elections in 2008 will change the political atmosphere for the better, which will positively impact on the growth of Taiwan's biotech industry.

Taiwan's rapid industrial and economic growth has put enormous pressure on the environment. Chemicals known to cause cancer have been detected in groundwater near the science-based industrial park at Hsinchu; cancer has been Taiwan's leading cause of death since 1982. The Chairman of Hon Hai Group announced plans to invest US\$ 3 billion in biotech efforts for cancer drug discovery and treatment after he lost his wife and brother to cancer. It is important that the growth of Taiwan's biotech industry is carefully monitored to safeguard the delicate island ecology and human health by strictly following professional code of conduct, corporate social responsibility, and local laws.

Outlook

Taiwan's economy is robust and ranks 17th in the world, supported by an abundance of foreign reserves. Because of its conservative financial approach and its entrepreneurial strengths, Taiwan suffered little from the Asian financial crisis of 1998 compared with many of its neighbors. Although the SARS epidemic, destructive typhoons, corporate/government scandals, and a drop in consumer spending have caused GDP growth to shrink to 3.2% in 2003, an increasingly strong export performance kept Taiwan's economy on track. Now, the government has high hopes for the biotech industry to strengthen its economy. Private investors from Taiwan's information technology have the capital and eagerness to fund, so private–public investments for the biotech industry may range from US\$ 5 to 10 billion in the coming years. Its close proximity to China and the language, ethnicity and entrepreneurial link between the two countries make Taiwan an ideal location and superb economic stepping stone to China's fast growing biotech market.

Considering all the above, the outlook is positive for Taiwan's biotech industry despite pressing challenges. Anti-cancer, anti-aging, tissue culture, and informatics are areas of active

research in biotech development and Taiwan's leading pharmaceutical companies are ready for the new drug development venture. Further biotech companies from overseas are destined to invest in Taiwan because of its proven talents in science and technology, state-of-the-art research institutions, entrepreneurial attitude, and strong government commitment to the biotech industry. Hence, the small island moves ahead to realize its big dream of a new economic miracle—the biotech industry!

References

- 1 Wallace, A.R. (1880) *Island Life*. London, MacMillan & Co.
- 2 Agoramoorthy, G. and Hsu, M.J. (2006) Taiwan's potential to assist developing countries to combat infectious diseases. *PLoS Med.* 3, 1192–1193
- 3 Liu, P. (2007) New law gives Taiwan's incipient biotech industry a boost. *Taiwan Eco. News* (http://cens.com/cens/html/en/news/news_inner_20170.html)
- 4 Ministry of Economic Affairs—Taiwan (2007) <http://www.dois.moea.gov.tw/main.asp>
- 5 NSC (2005) *Year Book of Science and Technology, Taiwan ROC*. National Science Council, Taipei, Taiwan.
- 6 Agoramoorthy, G. and Hsu, M.J. (2004) Indian scholars boost S&T research in Taiwan. *Curr. Sci.* 87, 131–132
- 7 CNA (2006) Ministry release corruption data. *Taipei Times*, 06 July, p. 2

Govindasamy Agoramoorthy

Department of Pharmacy, Tajen University, Yanpu, Pingtung 907, Taiwan
agoram@mail.tajen.edu.tw

Minna J. Hsu

Department of Biological sciences, National Sun Yat-sen University, Kaohsiung 804, Taiwan
hsumin@mail.nsysu.edu.tw