

Current Status of Bioindustry in South Korea

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Introduction

The history of South Korean bioindustry shows the existence of three stages:

- (a) 1980–1989 — Technology Development Stage;
- (b) 1990–1999 — Product Manufacturing Stage; and
- (c) 2000–current — Bioindustry Introduction Stage.

The technology development stage covered the introduction and development of new biotechnology, enactment of the biotechnology promotion law in 1983, establishment of biotechnology departments and research institutes in universities in 1984 and establishment of the Korea Research Institute of Bioscience and Biotechnology (KRIBB) in 1985. The product manufacturing stage included the establishment of Bioindustry Association of Korea (BAK) in 1991, formation of Biotech2000 program (MOST) in 1994, proclamation of Bioindustry Vision2000 (MOCIE) in 1994, development of bioprocess technology and launching of bioproducts. The bioindustry introduction stage comprised the establishment of the Korean Development Strategy in 2000. This is the key national strategic industry and involves the inauguration of National Bioindustry Action Plan, productivity improvement of generic products, development of new and modified bioproducts and increased investment in both public and private sectors.

As part of the strategy, the South Korean government initiated Biotech 2000, a five-year science and technology innovation plan aimed at enhancing government-funded research and development. Under this program, US\$20 billion will have been invested into biotechnology projects over the 14 years from 1994–2007. Biotech 2000 involves seven government ministers and is designed to have brought South Korean biotechnology to the same level as the world's industrialized countries by the year 2007. Research programs are on areas such as biomaterials, biomedical engineering, genome analysis, cell culture, food and environmental biotechnology and basic life sciences. Four hundred and seventy-three million US dollars was invested in R&D investment across seven ministries in 2003.

Research Portfolio

In areas such as fermentation technology, South Korea has reached the technological level of industrialized countries. However, a report by the KRIBB suggested that other areas of technology, such as separation technology and biomaterials, are still at an early stage of development. Figures from the Ministry of Science and Technology (MOST) showed journal publications (based on publications in journals listed by SCI) increased from 43 in 1991 to 498 in 2000. Patent registration to the US PTO (<http://www.uspto.org>) increased from two in 1994 to 26 in 2001. Three world-class research institutes drive the research sector in South Korea. These are the KRIBB, the MOGAM Biotechnology Research Institute and the POSTECH Biotech Center.

The KRIBB, established in 1985, is the only government research institute dedicated to biotechnology research across a broad span of expertise, from basic studies for the fundamental understanding of life phenomena to applied studies. MOGAM Biotechnology Research Institute was established in 1984 and is one of the best private research institutes. MOGAM focuses research and development into the field of biopharmaceuticals. Established in 2003, POSTECH Biotech Center is Korea's newest life science complex and boasts world-class scientific collaboration between academia and industry. In addition to these three main centers, there are nine bioventure centers, 15 new region promotion business, seven government-funded research institutes, eight national and public research institutes, two private research institutes (the other being Samsung Bioscience Research Institute), three research bioinformatics institutes and three microorganism depository organizations.

Industry organizations include the Bioindustry Association of Korea (BAK), the Korea Biotechnology Research Association (KBRA) and the Korea Bio Venture Association (KOBIOVEN). BAK is the main industry peak body and was established as an affiliated organization of the Ministry of Commerce Industry and Energy (MOCIE) in 1991, for the purpose of the development and growth of bioindustry in South Korea. Its main activities include the formation of a bioindustry platform and international cooperation. As of September 2004, 64 company, 22 organization and 84 individuals comprised the BAK member list. The KBRA was established as an affiliate organization of the MOST in 1982. Its purpose is the support of the development of biotechnology. The KOBIOVEN was established as an affiliate of the MOCIE in 2000.

Competitive Advantage

South Korean export earnings from bioindustry was US\$0.7 billion in 2002, and the goal of the government is to boost this value to US\$10 billion by 2012, with an ultimate aim to target a 10% share of the global market. Present strategies to gain competitive advantage on a global basis are:

- a) Development of core technology. The development of core technology includes technology for mid-term and next generation industries such as new biodrugs, artificial organs and biochips.
- b) Expansion of industrialization infrastructure. This includes the establishment of bioproduct manufacturing [international authorization of GLP (Good Laboratory Practice) system, establishment of a GCP (Good Clinical Practice) system for functional active compounds expansion of cGMP and improvement of management skills] and implementation of international biosafety legislation for LMOs (Biosafety Information Center and Foundation of Biohazard Evaluation Center).
- c) Strengthening and promoting bioclusters. This will be achieved through the construction of Korea Biohub, strengthening of existing bioclusters, promotion of the use of micro-biochip production platforms and establishment of platforms supporting industrialization of BIT technology. The construction of advanced biopharmaceutical production complexes and bulk vaccine production complexes will also be undertaken.
- d) Promoting global networks. The establishment of investment/consultant companies with participation from the public sector and private and foreign companies is hoped to support long-term investment of biotechnology in South Korea. Additional benefits are perceived through R&D collaboration with foreign countries, training international standard specialists and networking among domestic and foreign association, companies and governments.

Core Competencies and Capabilities

Table 1 shows the diversity of South Korean bioindustry. South Korean bioindustry's mid-term and next generation projects target the development of therapeutic protein by animal cell culture, development of biomaterials by intelligence-type bioinformatics, development of gene therapy for currently incurable diseases, mass production of protein-DNA chip systems and development of high value-added protein. Longer term goals include immunomodulator, drug delivery systems, gene therapy, cell therapy and cGMP technology.

There were 605 bioindustry companies in 2003 of which 173 were in R&D and 432 in sales. A breakdown of companies by size reveals approximately 30 large size (operating fully integrated R&D, production and marketing divisions), 70 medium size (focused on the competitive core products) and more than 500 small size and/or venture groups (individually concentrated on the Niche Fields of R&D, production or marketing). The bioindustry workforce was 11,013 in 2003 with 5808 (53%) in R&D and 5205 (47%) in manufacturing. Market size in 2003 was US\$1332 million, which included 61% biopharmaceuticals and 39% non-pharmaceuticals (Table 2). Product distribution was 68% and 32% for domestic and export products, respectively. The market was valued at around US\$1598 million in 2004.

Conclusion (SWOT)

- a) **Strength** — International level of IT technology, enthusiasm for education and strong driving policy of the government.
- b) **Weakness** — Inferior technology competitiveness, far behind level of industrial infrastructure and insufficient investment.
- c) **Opportunity** — To narrow the gap in the potential of Korea compared with developed countries, innumerable fields to be investigated and increased interest in bioindustry among the South Korean population.
- d) **Threat** — Spread of anxiety about the use of bioproducts, monopoly of patents and IPR by a limited number of companies and speed of technology development.

Acknowledgments

The authors compiled this article based on information provided by the Bioindustry Association of Korea, primarily sourcing a presentation entitled "Current Status of Bioindustry in Korea." This was provided by Jung-Hyun Woo, Senior Business Development Manager, Austrade's Seoul Office. 🌐

Table 1: South Korean Bioindustry Sectors

Areas	Contents
Biochemicals	Biopolymer, industrial enzymes, organic acids, amino acids, reagents and kits, bioagrochemicals, etc.
Bioenvironments	Wastewater and waste treatment, bioremediation, pollution monitoring, microbial agents, etc.
Biopharmaceuticals	Immunomodulator, growth factor, blood protein, antibiotics, vaccines, diagnostics, tissue and cell engineering, gene therapy, etc.
Bioenergy and Resources	Biomass and biogas, artificial seed and tree, transgenic animal and plant, marine bioresources, etc.
Biofoods	Amino acid, functional peptide and protein, functional lipid and carbohydrate, food additives and enzymes, etc.
Bioelectronics	DNA chip, protein chip, biosensors, bioMEMS, biodevices, etc.
Bioprocess and Bioequipment	Fermentation, cell culture, bioconversion, separation and purification, formulation, bioengineering, etc.
Bioevaluation and Bioinformatics	Safety evaluation, efficacy evaluation, biostandardization, bioinformatics, etc.

Source: Korea Institute of Industrial Economics and Trade (KIET) (2004).

Table 2: Bioindustry Market Size

Areas	Domestic Products	Imported Products
Biopharmaceuticals	545	267
Biofoods	148	1
Biochemicals	65	35
Bioenvironments	76	-
Bioenergy and Resources	11	2
Bioprocess and Bioequipment	26	122
Bioelectronics and Bioinformatics	33	1
Total	904	428
	1332	

Source: Bioindustry Association of Korea (BAK) (2004).