



Biotechnology and Life Sciences Education in China

Growth in the quality of Chinese universities has allowed the biotechnology sector to grow



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Biotecnology is definitely a hot topic in China—the country’s administrators recently identified it as a “cornerstone of China’s national economy by 2020.” But most realize that getting there will require a better trained, specialized workforce than currently exists. The Chinese government has been pumping money into life sciences education as part of its plan to achieve a global biotechnological presence over the next 15 years.

This article summarizes information from the recent BioPlan Associates and Society for Industrial Microbiology study, *Advances in Biopharmaceutical Technology in China*. We examine how investments have affected the growth of life sciences in China over the past few years.

BACKGROUND

In 1981, China outlined an educational degree system similar to that in the US. In 1995, China introduced a national strategy to “reinvigorate China through science and education.” One such high-priority program is the 211 Project, which focuses on funding major universities and key disciplines in China. Based on enrollment, employment, and economic data, these programs seem to be working.

STATISTICS

The sheer size of China’s population makes its education statistics eye-popping: in 2005, the total higher education enrollment in China hit a record of 23 million—the highest in the world. There were 2,236 higher education institutions in China including 684 undergraduate institutions and 1,047 junior colleges. The gross enrollment rate was 21% [QA: 21% of what?], with an 8.5% annual increase since 2000.¹ (Figures 1 and 2).

According to the Ministry of Education, by the end of 2004 there were 228 private higher

education institutions in China, with a total enrollment of 1.4 million students.² Following China’s entry to the world trade organization, many foreign universities have also opened facilities in China through cooperation with Chinese private schools.

NEW OPPORTUNITIES, FAST GROWTH

The 211 Project has funded 100 major university construction projects and improvements in education quality and scientific research. For example, over three years [QA: Which three years?], the government invested \$225 million in Tsinghua University and Peking University to help establish them as competitive world-class institutions. Total investments on the 211 Project reached \$2.3 billion used for key discipline creation, public service system construction, and basic facilities construction.

EDUCATION EXPENDITURES

China’s national education expenditures have been increasing in recent years (Figure 3). Despite this recent growth, overall education investment by the Chinese government is still very low when compared with international averages. In 2004, national education budget expenditures (NBEA) totaled \$90.5 billion. However, this only accounted for 2.8% of the country’s gross domestic product (GDP). The Chinese government’s goal is to reach 4% GDP in the near future.

The cost of higher education has grown dramatically in China. Before the 1990s, higher education was tuition-free for undergraduate students. Since then, tuition has been levied and fees have risen, and now exceed \$625 per academic year. This is still extremely low when compared with tuition in the US, where public universities charged an average of \$6,794 in 2003, and some private US institutions charged

in excess of \$30,000. Nonetheless, only about 20% of Chinese university students pay their own fees; the fees of the remaining 80% are paid by [QA: Who pays the fees for the other 80%?]

LIFE SCIENCES EDUCATION IN CHINA

Biotechnology degrees are offered at 235 universities in China, and more than 500 universities or colleges offer full biology-related programs. In 2004, there were more than 150,000 undergraduate students enrolled in biology-related programs. Between 1996 and 2002, 15,000 PhD students were enrolled in biology-related majors. Based on this data, 30,000 biology PhD students will obtain their degrees between 2005 and 2020.³

Enrollment of biology undergraduate students has increased dramatically. In 1997, 48,093 undergraduate students were enrolled in biology. In 2003, enrollment rose to 152,209.

MEDICAL EDUCATION

Modern medical education has a 100-year history in China. In 1903, the government of the Qing Dynasty established the Medical Clinic at the Royal Capital Higher Educational Institute, and the level of medical education has greatly improved in terms of size, quality, and efficiency. Today, China has 177 higher medical education institutions, with an enrollment of 718,400 students in 2000, but gaps still exist. In China, a medical professional who holds a bachelor's degree in medicine and has one year of practicing experience can take the licensed doctor exam and obtain a legal medical doctor license. China has developed an evaluation system to evaluate its medical universities, however; this may lead to improvements. [QA: Comment added. Ok?]

PROBLEMS AND CHALLENGES FACING CHINESE UNIVERSITIES

China's higher education system is

Figure 1. Undergraduate enrollment in higher education institutions (1998–2005)

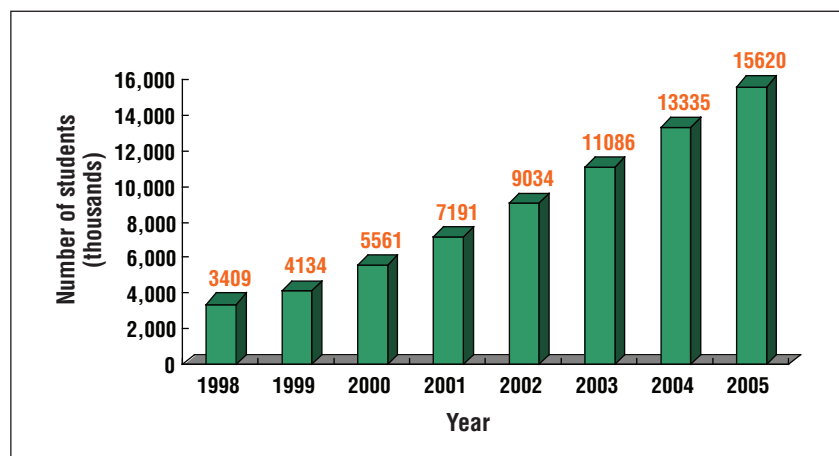


Figure 2. Graduate enrollment in higher education institutions (1998–2005)

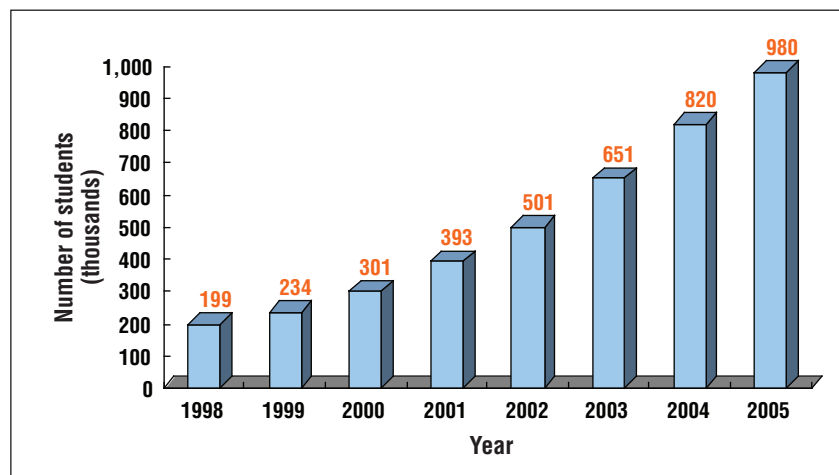
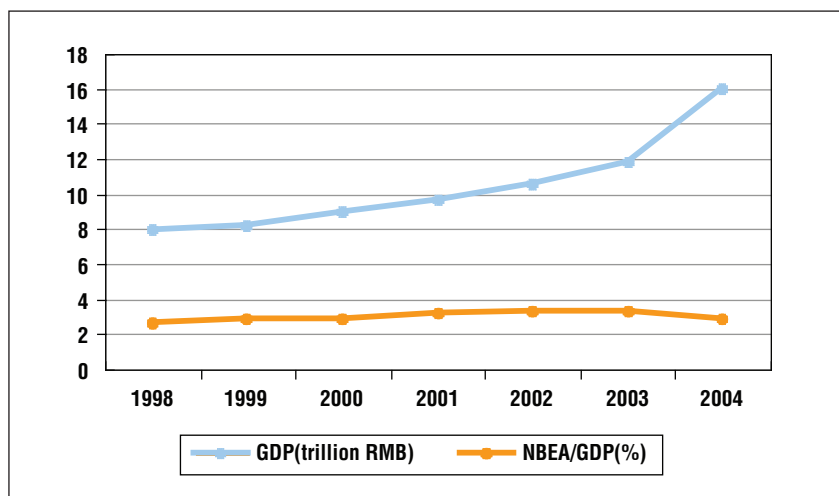


Figure 3. China's GDP and national budgetary education allocation (NBEA) (1998–2004)



Life Sciences Education Timeline

- **Beginnings (1913–1949):** Chinese scholars first introduced biology education into China in 1913 at Dongwu University. By 1949, more than 40 Chinese universities had set up biology majors.
- **Reconstruction and improvements (1949–1979):** During the major reform in 1952, the frameworks of most universities changed significantly.
- **Cultural Revolution (1965–1975):** During this time, politics interfered with academics. [QA: Can we expand on this?] Most universities faced devastating damage and ceased to function.
- **Reestablishment and development (1977–1990):** Admission examinations in biological science education returned to Chinese universities.
- **Reorganization and optimization (1990–present):** Two-thirds of universities established a new education system managed by both central and local governments. Many universities merged.

now shifting its focus from size expansion to quality improvement. Four key hurdles face them:

- **Lack of funds:** The annual expenses of a Chinese undergraduate is 5% of that of a US undergraduate.
- **Shortage of faculty:** The current teacher to student ratio is 1:16 versus 1:14 in the US.

Table 2. Graduate students majoring in biology and bioengineering in China

Year Major	1997	1998	1999	2000	2001	2002	2003
Biosciences	9,095	8,785	9,105	8,326	7,647	10,768	13,752
Biotechnology	1,857	2,216	2,590	2,761	2,130	3,340	5,696
Bioengineering	1,480	1,339	1,470	1,867	1,586	2,274	2,257
Total	12,432	12,340	13,165	12,954	11,363	16,382	21,705

- **Decreasing education quality:** With the swift expansion of higher education and the constant increase of gross enrollment rate, educational quality has slumped.

- **International integration:** The Chinese government has promised to open higher education markets to the outside world, forcing competition.

BIOMEDICAL PUBLICATIONS

A useful index for evaluating universities is their academic and research publications. Chinese universities have made notable progress in the publication of biomedical research papers (Table 1). From 1981 to 2003, there was a 20-fold increase in the number of Chinese papers published in journals indexed by the science citation index (SCI). In 2004, a total of 57,377 Chinese research papers were indexed by SCI, a 15.2% increase over 2003, accounting for 5.43% of all SCI papers, and ranking fifth place after the US, the UK, Japan, and Germany. SCI-indexed international papers authored by Chinese scientists reached 32,536.⁴

CONCLUSION

China has experienced a brain drain since the mid 1980s as a growing number of Chinese students have gone abroad to pursue higher-level education. Many have stayed abroad

Table 1. Top 10 Chinese universities ranked by total cites of SCI-indexed Chinese papers (1995–2005)

Rank	University	Total cited papers	Total cites
1	Tsinghua University	6,394	30,345
2	Peking University	6,272	36,121
3	Nanjing University	5,384	31,538
4	Zhejiang University	4,807	21,970
5	Chinese University of Science and Technology	4,576	25,011
6	Fudan University	3,894	22,301
7	Jilin University	2,677	13,651
8	Nankai University	2,608	12,446
9	Shandong University	2,518	10,609
10	Shanghai Jiao Tong University	2,233	9,331

for years, acquiring research or commercial experience. A survey of the life sciences school at Peking University showed that 72% of Peking University masters and PhD graduates between 1998 and 1999 chose to go abroad for further study or post-doctoral research.⁵

China is working to reverse this. Many Chinese universities are offering incentives to lure graduates back, including competitive salaries, comfortable accommodations, and flexible work schedules allowing them to work both in China and abroad.

Many believe that the key to China's success will be in education and the training of innovation [QA: Please clarify. Training students to be innovative?] in the biotechnology field. This success will be measured against international standards. With a growing number of Chinese returnees who have acquired experience in Western countries, China's talent pool is on the road to achieving world-class quality. ♦

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