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and reducing the scale of the disease burden that many other developed countries have had.²⁻⁶

How China fares is important not only for Chinese people but also for the global health community. The global importance of China is assured by its size and scale, its wellspring of innovation, and its role in shared risks and interdependent solutions. In the future, China's global-health interactions will undoubtedly accelerate—in areas such as science and technology, research and development, clinical trials, and new procedures such as organ transplantation. China will also be the source of social system innovations, such as its real-time online disease surveillance system. History has shown that China can produce and harness knowledge, create innovative approaches, and implement at large-scale effective solutions for both its own people as well as the world community.

This report aims to initiate long-term collaboration between *The Lancet* and China, together with the China Medical Board and WHO, including critically important partners, such as scientists outside China who have strong interests in working with Chinese colleagues. The purpose of this collaboration is to introduce China's health system, achievements, and predicaments to the world and to foster scientific and institutional alliances that can strengthen the health—and ameliorate the adverse social and environmental determinants of health—of the Chinese people. We are at the beginning of this relationship. Our report, we hope, has the potential to catalyse progress towards enhanced human health and wellbeing in China.

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- 1 Tang S, Meng Q, Chen L, Bekedam H, Evans T, Whitehead M. Tackling the challenges to health equity in China. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61364-1.
- 2 Wang L, Wang Y, Jin S, et al. Emergence and control of infectious diseases in China. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61365-3.
- 3 Yang G, Kong L, Zhao W, et al. Emergence of chronic non-communicable diseases in China. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61366-5.
- 4 Wang SY, Li YH, Chi GB, et al. Injury-related fatalities in China: an under-recognised public-health problem. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61367-7.
- 5 Anand S, Fan VY, Zhang JH, et al. China's human resources for health: quantity, quality, and distribution. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61363-X.
- 6 Hu S, Tang S, Liu Y, Zhao Y, Escobar M-L, de Ferranti D. Reform of how health care is paid for in China: challenges and opportunities. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61368-9.
- 7 Liu Y, Rao K, Wu J, Gakidou E. China's health system performance. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61362-8.
- 8 Chen Z. Biomedical science and technology in China. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61352-5.
- 9 Dong Z, Phillips MR. Evolution of China's health-care system. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61351-3.
- 10 Tang J-L, Liu B-Y, Ma K-W. Traditional Chinese medicine. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61354-9.
- 11 Xiao S, Kohrman M. Anthropology in China's health promotion and tobacco. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61361-6.
- 12 Fang J, Kaufman J. Reproductive health in China: improve the means to the end. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61356-2.
- 13 Zhang K-L, Detels R, Liao S, Cohen M, Yu D-B. China's HIV/AIDS epidemic: continuing challenges. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61357-4.
- 14 Wang L, Utzinger J, Zhou X-N. Schistosomiasis control: experiences and lessons from China. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61358-6.
- 15 Zhang D, Unschuld P. China's barefoot doctor: past, present, and future. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61355-0.
- 16 Wang R, Henderson GE. Medical research ethics in China. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61353-7.
- 17 Huang J, Mao Y, Millis JM. Government and organ transplantation in China. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61359-8.
- 18 Hu X, Cook S, Salazar MA. Internal migration and health in China. *Lancet* 2008; published online Oct 20. DOI:10.1016/S0140-6736(08)61360-4.
- 19 Countdown Coverage Writing Group, on behalf of the Countdown to 2015 Core Group. Countdown to 2015 for maternal, newborn, and child survival: the 2008 report on tracking coverage of interventions. *Lancet* 2008; **371**: 1247-58.

Biomedical science and technology in China

Advances in medicine in the 20th century, along with an ageing population and changes in lifestyles, have altered the nature of diseases. Malnutrition and traditional infectious diseases have been replaced by chronic non-communicable diseases and emerging infectious diseases. In China, more than 80% of deaths

are caused by chronic non-communicable diseases. These increasing worldwide needs have placed biomedicine centre stage. The development of biomedical research in China, a country with 1.3 billion people, is a massive and unique challenge.¹ Initially when China opened its doors via policy



Published Online
October 20, 2008
DOI:10.1016/S0140-6736(08)61352-5
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reform, economic issues were the major concern and Deng Xiaoping advocated the notion of “science and technology constituting a primary productive force”.² In the mid-1980s, when the national high-technology programme (863) was launched,³ biotechnology was the main priority.

Since the mid-1990s, China has used science and education to improve its international competitiveness,⁴ with an increase in expenditure on research and development from 0.6% of gross domestic product (GDP) in 1996 to 1.4% in 2006 (a period during which the annual rate of growth in GDP reached more than 9%).⁵ At the same time, China set up policies to develop its talent pool in biomedical research, and is ranked fourth internationally in 2005 for patents granted and publications in indexed journals.⁶ More than 20% of the Government’s research and development budget was spent on life science and biotechnology, including health-related domains.

While encouraging investigator-initiated projects by augmenting the budget of the National Natural Science Foundation (a five-fold increase over the past decade, rising to 4.3 billion Renminbi [about £0.32 billion] in 2007), China has also launched the national key basic research programme (973) and established major scientific facilities, including synchrotron light-sources and centres for genomics or protein science, drug

screening, and biodiversity conservation. By combining resources in human genetics and traditional Chinese and western medicine, a comprehensive medical research system has been developed.

In addition to the contribution to sequencing of the human genome and the HapMap Project,⁷ scientists sequenced the genomes of several important species (including rice, chicken, the domesticated silk-moth, and *Schistosoma japonicum*). The molecular pathogenesis of infectious outbreaks, such as severe acute respiratory syndrome (SARS)⁸ and avian influenza,⁹ and several chronic diseases has also been analysed.¹ The development of selective differentiation or apoptosis induction in acute promyelocytic leukaemia is an example of how functional genomics can promote targeted cancer therapy.¹⁰

China has joined international research efforts in proteomics and structural genomics. Crystal structures of several protein complexes, including mitochondrial respiratory chain complex II, have been characterised,¹¹ and the first human proteome catalogue for the liver has been generated.¹² Advances in other domains have also been made—eg, the effect of lymphoid microenvironments on dendritic cells¹³ and signal transduction, such as the involvement of β arrestin in the regulation of G-protein-coupled receptor signalling.¹⁴ Biochips have been applied to clinical medicine and food safety. China is the first country to issue approval through the Government’s regulator (the State Food and Drug Administration [SFDA]) for the use of biochips to screen for diseases such as hepatitis C.

China approved the world’s first gene-therapy product (recombinant human serotype 5 adenovirus, Gendicine) for TP53 tumour suppressor.¹⁵ Almost 100 new drugs have either been introduced into the market or are in late-phase clinical trials, such as analogues of artemisinin (a key component in combination therapy for malaria, and recommended by WHO), and quick-test diagnostic reagents for HIV/AIDS. Especially noteworthy are achievements in vaccines for SARS and avian influenza, and the establishment of important platforms for antibody studies.

In stem-cell research, there have been patents and the setting of standards for animal cloning, generation of human embryonic stem-cell lines, nuclear transfer of somatic cells, somatic stem-cell isolation or characterisation, expansion and directed differentiation



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of stem or progenitor cells, and tissue or organ engineering. For example, the use of mesenchymal stem cells to support haemopoiesis during bone-marrow transplantation is now in clinical trials, and the SFDA has recently ratified a certificate for a novel artificial skin.

Yet China faces several challenges, including: the need to develop a sound infrastructure for health-care insurance; a lack of effective partnership between the academic and industrial sectors; insufficient investment in drug research and development; and unsatisfactory support for the oversight of food and drug safety.

With the move towards the Outlook of Scientific Development and the aim of developing an equitable society, China has placed public health at the top of its agenda, with the aim of Health for All by 2020.¹⁶ At present, the country is concentrating on primary health care in rural areas and community medicine in cities. The initial goal is a framework for delivery of health care and an insurance system that will cover most people by 2010, in which governmental funding will take the lead. By the end of 2008, the New Rural Cooperative Medicare Scheme, with an 80% contribution from public coffers, will cover all 860 million farmers in China. New initiatives to cover all urban citizens have also been launched.

To use biomedicine to boost accessibility and equal provision of health care, a strategy of “walking on two legs” has been advocated. This strategy suggests that excellence in cutting-edge technologies should be pursued along with a serve-all approach. In the *Guidelines on National Medium- and Long-term Program for S&T Development (2006–2020)*, drug innovation and prevention and control of major emerging infectious diseases have been listed as two of 16 mega projects.¹⁷

In line with the notion of predictive, preventive, personalised, and participatory medicine, disease prevention should be a priority, with importance attached to provision of clean drinking water, environmental health, natural disasters and disaster preparedness, large-scale production of good-quality food, drug, and vaccine production and regulation, production of reliable reagents for diagnosis and screening, and development of an e-health-care system to manage chronic non-communicable diseases. Moreover, modernisation of traditional Chinese medicine will be strengthened by multicentre clinical trials to evaluate efficacy, and to implement standardisation and quality

control, and also by studying systems biomedicine.¹⁸ China’s translational research capacity will be improved by combining its clinical resources and research strength, while creating an environment that considers ethical, legal, and societal input. While encouraging indigenous innovation, China needs to further extend international collaboration through personal exchanges and joint projects. We believe that all these factors will contribute to the improvement of public health in the 21st century.

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This Comment benefited considerably from constructive discussion with Zhan Qimin, Chinese Academy of Medical Sciences. I declare that I have no conflict of interest.

- Chen Z, Wang HG, Wen ZJ, Wang Y. Life sciences and biotechnology in China. *Philos Trans R Soc Lond B Biol Sci* 2007; **362**: 947–57.
- Deng X. Science and technology constitute a primary productive force. In: Den X. Selected works of Deng Xiaoping, vol 3. Beijing: People’s Press, 1993: 274–76.
- Office of 863, Ministry of Science and Technology. Introduction of 863 Program. http://www.863.org.cn/863_105/863brief/863introduction/200405080289.html (accessed July 23, 2008).
- Jiang Z. Implementing the strategy of developing the country through Science and education. In: Jiang Z. Selected works of Jiang Zemin, vol 1. Beijing: People’s Press, 2006: 425–39.
- China Science and Technology Statistics. Data book 2002. <http://www.sts.org.cn/sjkl/kjtjdt/data2002/2002-2.htm> (accessed July 23, 2008).
- China Science and Technology Statistics. Data book 2007. <http://www.sts.org.cn/sjkl/kjtjdt/data2007/2007-6.htm> (accessed July 23, 2008).
- The International HapMap Consortium. A haplotype map of the human genome. *Nature* 2005; **437**: 1299–320.
- Chinese SMEC. Molecular evolution of the SARS coronavirus during the course of the SARS epidemic in China. *Science* 2004; **303**: 1666–69.
- Liu J, Xiao H, Lei F, et al. Highly pathogenic H5N1 influenza virus infection in migratory birds. *Science* 2005; **309**: 1206.
- Wang ZY, Chen Z. Acute promyelocytic leukemia: from highly fatal to highly curable. *Blood* 2008; **111**: 2505–15.
- Sun F, Huo X, Zhai Y, et al. Crystal structure of mitochondrial respiratory membrane protein complex II. *Cell* 2005; **121**: 1043–57.
- Human Proteome Organisation. Human Liver Proteome Project. <http://hupo.org/research/hlpp> (accessed July 23, 2008).
- Zhang M, Tang H, Guo Z, et al. Splenic stroma drives mature dendritic cells to differentiate into regulatory dendritic cells. *Nat Immunol* 2004; **5**: 1124–33.
- Kang J, Shi Y, Xiang B, et al. A nuclear function of beta-arrestin1 in GPCR signaling: regulation of histone acetylation and gene transcription. *Cell* 2005; **123**: 833–47.
- Guo J, Xin H. Chinese gene therapy: splicing out the West? *Science* 2006; **314**: 1232–35.
- Hu J. Full text of Hu Jintao’s report at 17th Party Congress. 17th CPC Congress. Oct, 24, 2007. http://news.xinhuanet.com/english/2007-10/24/content_6938749_7.htm (accessed July 23, 2008).
- State Council, People’s Republic of China. Guidelines on national medium- and long-term program for science and technology development (2006–2020). Feb 9, 2006. http://www.gov.cn/jrzq/2006-02/09/content_183787.htm (accessed July 23, 2008) [in Chinese].
- Eastern Forum of Science and Technology. Systems Biology and Medicine. 53rd Eastern Forum of Science and Technology. 2004. <http://www.efst.sh.cn/showMeet.do?id=145> (accessed July 23, 2008) [in Chinese].