SCIENCE AND SOCIETY

Achieving Scientific Eminence Within Asia

Asian countries are poised to help solve modern biological problems, but some policies and practices need reform.

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Will Asia be a strong science partner in the 21st century? Our future depends on solving critical problems, many of which require scientific or technical solutions. Asia, which contains two-thirds of the world's population, should be a source of considerable talent for tackling these problems. It has the advantage of geographic size, a youthful population, and increasing wealth. Scholarly activity has been widely respected in Asian cultures throughout their history. Over 400,000 Asian students enrolled in U.S. universities come from Asia (*1*). In the past, many of these students remained in the United States, but recently an increasing number are returning to their homelands. In response, several Asian countries are attempting to build fundamental research establishments to accommodate these returnees and to increase science capacity (*2*).

Asian nations are extraordinarily diverse, from small city-states to the most populous countries in the world. Some of these, most notably China, India, South Korea, Taiwan, Hong Kong, and Singapore, have greatly improved their economies and have begun to invest heavily in their educational and research institutions. Japan, one of the wealthiest Asian countries, has had a continuous research establishment for more than a hundred years and yet is also recognizing the need to reform and build. Even the emergent economies of Malaysia, Thailand, Indonesia, and Vietnam aspire to build their own research capacity, especially in the areas of discovery and innovation.

However, we sense that Asian countries share some aspects of mindset and culture that limit their aspirational reach. Here, we cite common problems that we think can be avoided or overcome. Our perspective is that of practicing scientists and administrators who have worked mostly in the West, but who also have an understanding of Asia's cultures and rich history [e.g., C.Y.H.T. is founding director of Singapore's Institute of Molecular and Cell Biology (IMCB)] (*3*). We believe success can be enhanced in each Asian country by following the eight recommendations in the table.

Asian investment in modern fundamental science did not begin until roughly 25 years ago. Unlike manufacturing, which is based on low cost labor and materials, fundamental research depends on the discovery of new knowledge that could lead to valuable new products. After considerable investment in buildings and equipment, Asian countries have come to appreciate that more is needed to build a vibrant research culture that is capable of world-class competitive research (*4*).

1	Reform rote education by teaching active learning starting with the very young.
2	Establish a culture that rewards creative thinking and innovation.
3	Provide independence for young investigators immediately after their training.
4	Fund a large number of independent small and midsize groups to build a large base for innovative research.
5	Nurture young scientists in an open environment that encourages international collaborations.
6	Use the wisdom of experienced older scientists who understand the country's culture to create clear career paths and astute national science policies.
7	Establish transparent systems of competitive research funding based on merit.
8	Establish a culture that insists on scientific integrity and honesty.

In the past, there was also a lack of cooperation and interaction among Asian research institutes, especially across national lines. For example, despite its developed economy, Japan's science establishment had very little interaction with the rest of Asian science. But since the 1990s, with newly established ties developed through science, we have seen a spirit of camaraderie among scientists in Taiwan's Institute of Molecular Biology, Singapore's IMCB, Hong Kong's University of Science and Technology, China's Beijing University and Institute of Biochemistry (Shanghai), Japan's Institute of Medical Science at the University of Tokyo, Indonesia's Eijkman Institute, Korea's Seoul National University, Australia's University of Queensland, and New Zealand's University of Otago. The recent mapping of human genomes in Asia was accomplished with the collaboration of 40 institutions throughout Asia (*5*). Also, scientists from 14 countries, with shared values and vision, joined to form an Asian-Pacific International Molecular Biology Network (A-IMBN; www.a-imbn.org/) in 1997. A-IMBN is a grassroots organization. that may well be the beginning of pan-Asian partnerships among scientists throughout Asia, similar to the European Molecular Biology Organization. These unprecedented developments demonstrate the potential capabilities already building in Asia.

Passive rote learning served China and India well for 3000 years. Civil servants were selected through tough imperial examinations based on how well they could recite from rote. Rote learning is entrenched and ingrained to this day in many areas of Asia (*6*). For example, in China and Japan, primary school students spend hours practicing calligraphy: the proper positioning and writing of each word within a box. This is not an environment that encourages "outside-of-the-box" thinking. The Indian Institute of Technology (IIT) is legendary for conducting rigorous entrance examinations, where 320,000 may take the exam, and only 8000 are accepted. But IIT may not always challenge the exceptional student once admitted (*7*). We believe that this is also true of many other institutions of higher learning throughout Asia. To compete internationally, Asia must establish a culture that rewards creative thinking and innovation. To do so, the mindset must change to promote active learning. But this takes time. In the interim, some of the best "teaching" may be via the Internet. But despite good Internet access, there is concern regarding censorship and control.

One way for countries to increase creative thinking in science is to attract their own scientists who have trained abroad to return. Ray Wu, a professor from Cornell University, made an agreement with China in 1980 to select young graduates from China's top universities and send them to leading American universities to obtain their graduate degrees in biology and biochemistry. Selected students were put on a crash course to speak and

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write English before they entered the United States. By 1989, 422 students from China were training for their Ph.D.'s through this China–United States Biochemistry Examination and Application (CUSBEA) program (*8*). Within a decade, CUSBEA students changed the landscape of American research laboratories. For the first time, a large number of students from China in the United States were coauthors of outstanding publications in international journals. Many stayed in the United States and established excellent independent reputations.

Both China and Singapore have focused on this group, hoping to attract them back to Asia. At least 30 successful CUSBEA graduates and other Chinese professionals in the United States have recently given up major professorships to return to China (*9*, *10*). Singapore's IMCB has also hired several CUSBEA graduates. Although it may be too early to judge, their return to Asia suggests that competitive scientific research may be built within a generation when enthusiastic, well-trained young scientists are given the opportunity to establish independent research programs.

It is difficult to "leap frog" to excellence, however, just by writing large checks in support of science. There are many gaps to be filled despite good intentions. Our observation of science in Asia reveals a remarkable similarity in policy-making. Science policy is typically a top-down process involving senior politicians and civil servants. Few have science discovery backgrounds, and middle-level bureaucrats accustomed to counting returns on investment carry out implementation. These individuals tend to adapt their version of metrics to measure productivity and success in science. Many Asian bureaucrats are finding out that scientific discovery is not readily quantifiable by returns on financial investment within their years of service. Such disappointments can lead to reprioritization of government support, interfering with and jeopardizing newly founded laboratories and often destabilizing careers.

The present Asian research community can be grossly divided into a majority of older, local scientists, with a minority of younger returnees and visiting scientists from the West. In Singapore there is an additional group, a small group of senior Western scientists recruited into part-time or full-time positions and entrusted to lead the science effort. Many of these expatriate scientists are well past retirement age. Managing these different groups of scientists at any one time is difficult, especially through a top-down, decision-making process.

Centralized, top-down control will continue to affect the development of science in Asia. It has generated debate about whether "big science" is the wave of the future or small, independent laboratories would provide the innovative science that is needed. Inherently, big science is accompanied by "big politics." It is easier to sell big science not only because it is fashionable, but also because of its many easily measureable tangibles, such as modern buildings and expensive hardware. It would be alarming if Asia's newfound wealth goes largely to support big science because large facilities, instruments, and popular trends wear out and the rapid pace of discovery renders them obsolete. Worse, it reduces the base of innovations that Asia desperately needs to expand.

In Singapore, the debate is whether it is wiser to depend on established, Western senior scientists to lead (*11*) or better to grow a science leadership with younger returnees. A balance is needed, although we believe that younger returnees should be given the lead (*3*, *12*, *13*). Senior scientists, with their breadth of experience, provide the perspective needed for internal policy development and mentoring of young scientists. But young researchers in their prime are a better bet for innovation. They are likely to have the cutting-edge research knowledge, as well as ambition and energy, to be highly successful.

Asia can blaze a trail for encouraging innovative research by supporting large numbers of young returning scientists with access to funding that does not depend on cronyism and is competitively awarded on the basis of merit and productivity. If there are no clear career paths for scientists in Asia, the best and brightest will not be attracted to and remain in science as a career. One example of the failure to protect a bright scientist from changing administrative policies is that of a Stanford Ph.D. now making a living as a taxi driver in Singapore (*14*). Several Western-trained Asian returnees, including CUSBEA scientists have left Singapore for China.

The polemics between the traditional and the new continue, especially in Japan. Kenichi Arai, returning from Stanford, fought hard to reform the top-down, hierarchical system of life science research in Japan (*15*). One curious end product, derived from the reform movement there, was the birth of a new institute in Okinawa. Because Singapore's success story with IMCB was reported throughout Asia, Koji Omi, who was then both Japanese Minister of State for Science and Technology Policy, and also Minister of State for Okinawa, decided to build the world's best research institution in Okinawa. English would be the common language. Breaking with Japanese tradition, he appointed Sydney Brenner, an English Nobel laureate, to be the president of this entity, the Okinawa Institute of Science and Technology (OIST). During OIST's first year, Yomiuri Shimbun, a major Japanese newspaper, wrote critically of the OIST president (*16*) but missed the opportunity to discuss the reform of science in Japan. Resistance to reform is not particularly a Japanese problem. It is inherent in cultures with long, proud histories. OIST teaches an important lesson: It takes more than inviting a few high-powered scientists from abroad to get acceptance for science reform.

Unfortunately, throughout Asia, the respect for scholarship has translated to a virtual worship of the Nobel Prize and branding opportunities offered by top universities. Nobelists and professors from well-known Western universities represent the ultimate intellectual authority. Huge sums of money have been and are being spent in the hope of fast-tracking scientific institutions in Asia by associating with famous universities abroad. As an example, Singapore tried several expensive partnerships with U.S.-based Johns Hopkins University and the Massachusetts Institute of Technology (*17*, *18*).

How can Asia nurture its own scientific leadership with such a lack of confidence in its own talent? If not corrected, intellectual colonialism can become a serious barrier to Asia's quest to build capacity in science. Asia's ambition to build competitive institutions can still be achieved if educated, enlightened politicians and scientific leadership arise in, or return to, each country and are empowered to serve each region's best interests.

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