A WORLD THAT BANKS ON SCIENCE

A Speech by Bruce Alberts, President
National Academy of Sciences
Presented at the Academy's 141st Annual Meeting
April 19, 2004

It is difficult for me to believe that I am today presenting my 11th annual report to you on the goals and progress of the Academy, and that I will make only one more of these addresses. A nominating committee of 31 members, chaired by Peter Raven, has been working for the past six months to find my successor; and the next president of the National Academy of Sciences should be elected in time to provide for a six-month transition in leadership beginning July 1, 2005.

During my presidency, I have repeatedly emphasized the two fundamental goals of the National Academy of Sciences: first, to work tirelessly to strengthen the U.S. scientific enterprise in the national interest, and second, to spread science and its values vigorously throughout our nation and the world.

The challenge to each generation of Academy leadership has been to design the most appropriate strategies to achieve these two goals. Both science and the world that we live in are constantly changing; and for the Academy to thrive and be most effective, the strategies we use must also change. Being the president of this institution therefore presents a deep intellectual challenge. As in any major program of scientific research, the best way forward is often not obvious, and many choices of direction must constantly be made.

An Ambitious National Agenda

Meeting the Many Challenges of Bioterrorism

We are pleased when we produce a report that is so timely and effective that it has an immediate, profound effect on government policy. Our pathbreaking report *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*, released in June 2002, was one such example; *Biotechnology Research in an Age of Terrorism* (see Figure 1) is another. The committee that produced the latter report, chaired by Academy member Gerry Fink, included an equal number of leaders in the biomedical

Bruce Alberts, president, National Academy of Sciences

sciences and leaders with extensive experience in security issues. In its report, released last October, the committee specified seven classes of "experiments of concern," and it recommended that a system of oversight by scientists be established, built directly on the processes pioneered by the Recombinant DNA Advisory Committee at the National Institutes of Health. Both this central recommendation, and a second one proposing a high-level advisory board to establish and adjust policies, were implemented by the Department of Health and Human Services in early March at a cabinet-level press conference that praised the National Academies for its work. And we are now exploring ways to implement another key recommendation — that this issue be addressed internationally.

Within a few weeks, a committee chaired by Academy member Steve Harrison will release a special report on promising opportunities for the development of antiviral drugs for smallpox. This report suggests novel approaches to facilitate the discovery of treatments for this deadly disease, and it advocates recruiting outstanding scientists and new types of expertise to poxvirus studies and to the field of virology. The report will be published as two adjacent articles in the *Proceedings of the National Academy of Sciences*, one describing the science and the other on policies to speed the availability of new protective agents.

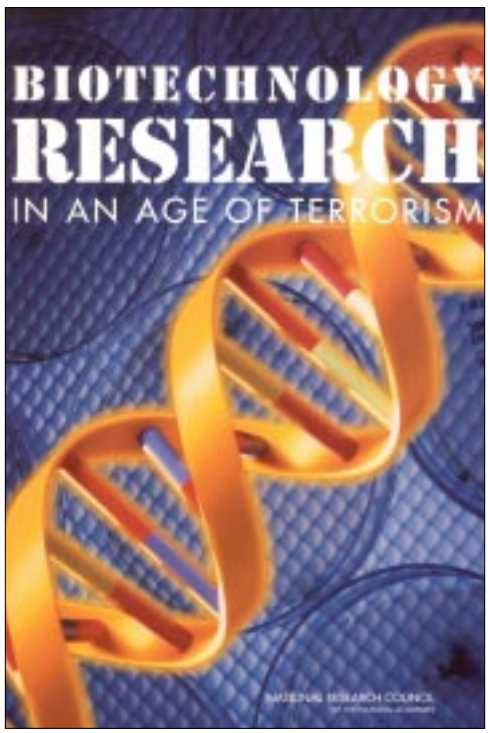

FIGURE 1

Protecting the National Interest by Ending a Continuing Visa Crisis

The world leadership of the United States in science and technology has created the vibrant U.S. economy, promoted our health and welfare, and empowered our modern military. But some of the U.S. government's responses to September 11th and its aftermath are clearly damaging this position of leadership. In particular, the new visa restrictions, intended to catch potential terrorists, have been so indiscriminately applied that they have made it difficult — and even degrading — for many outstanding foreign students and scientists to enter the United States.

A full quarter of the members of this Academy were born elsewhere. As we all know, foreign-born scientists and engineers have long provided an immense stimulus to both academia and industry in the United States.

A recent survey from the Council of Graduate Schools indicates that the number of foreign students applying for graduate study in the United States has declined 32 percent from last fall. Decreases in students from China and India are particularly large. The fields hit the hardest are engineering

and the physical and biological sciences. Clearly, many of the best students from other nations are now choosing to study elsewhere; in the future, their younger siblings will no doubt tend to follow them, no matter what is done in the future to improve our visa policies.

We are also continuing to insult the leaders of the science and engineering enterprise in other nations. Far too often, the conditions that they are required to meet when they attempt to get a visa are insulting. It will take time to realize the full impact of the deleterious effects of all of these actions. We are, in effect, "boiling a frog slowly." But we will lose something that is irreplaceable if this dreadful situation persists much longer.

The Academy has been working with other deeply concerned national organizations such as the Association of American Universities, the American Association for the Advancement of Science, and the Center for Strategic and International Studies — as well as with the Department of State and other parts of our government — to produce a shared action plan designed to mobilize the change needed across the government to fix our visa problems. Once we have such a plan, we will need to harness the energy of each of your institutions to move it to the top of the national agenda. With your Vice President Jim Langer, I am pushing hard for agreement on a publicly announced consensus that we can all support within the next few months.

Guiding the Adoption of New High-Stakes Science Tests by Each State

We must also, of course, pay close attention to producing the best possible scientists at home. To do this successfully, scientists will need to take more responsibility for science education at all levels, from elementary school through college. I have emphasized this theme throughout the past decade; this year I will address a single issue that each of us needs to follow closely.

Important decisions that affect science will soon be made because of the "No Child Left Behind" Act. In 2007, high-stakes science assessments will be coming to all of our K-12 schools. It is left to each state to decide what science tests it will select for all its students. My discussions with the experts who comprise the new Teachers Advisory Council of the National Academies (Figure 2) have convinced me that — because the test scores will be widely advertised and used to rank schools — our nation's science teachers can be expected to align their teaching with whatever test is chosen. For this reason, it is critical that each state use a science test that measures what we want students to understand and be able to do.

Unfortunately, the least expensive tests will often be those that focus on "science

A Teacher Advisory Council to the Nation: Does Every State also Need One?

FIGURE 2

facts" and on definitions of science words, where students are tested through multiple choice formats that can be scored by machine. We know that teaching to achieve good results on these types of tests can eliminate all inquiry from science classes, and it will certainly turn most students away from science, including many potential scientists. The National Academies are in the midst of an important study — requested by the National Science Foundation — that will soon provide guidance to the states with regard to the design and the development of science assessment systems. In the meantime, I refer you to the state assessments in Delaware and Washington, which have closely involved both scientists and teachers in designing their state examinations (see <www.doe.state.de.us> and <www.k12.wa.us>). I urge each of you to pay attention and get involved in your state.

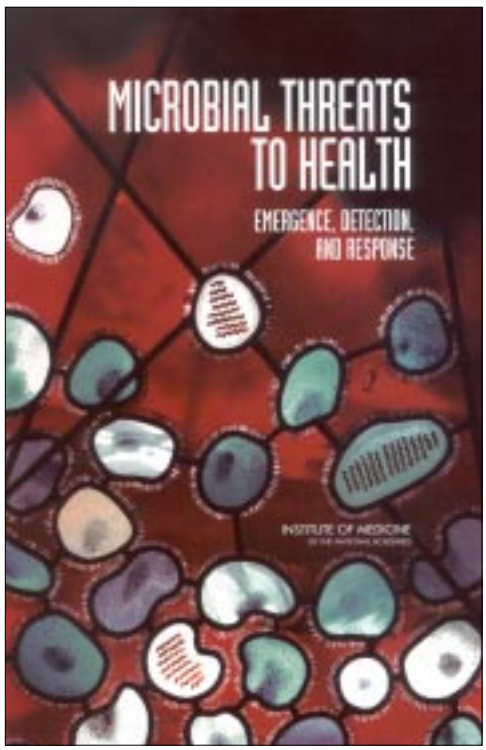

FIGURE 3

Getting Intellectual Property Right

Today, an important report will be released from a committee co-chaired by Yale University president, Rick Levin. This detailed study takes a close look at the U.S. patent system, and it recommends how we can make this system better serve its original purpose of stimulating innovation. A follow-up report that focuses on genomics patenting is already under way, chaired by our foreign associate Shirley Tilghman, president of Princeton University.

Serving the Nation through an Insistence on Sound Science

Unlike the "policy for science" activities just described, most of the reports that the National Academies produce each year for our government address "science for policy." Each of these presents a consensus view of the science and technology that underlie a particular set of decisions confronting policymakers. Some striking examples released in the past year are major reports on the hydrogen economy; on scientific criteria to ensure safe food; on microbial threats to health (Figure 3); on the effects of oil production on Alaska's North Slope; on weighing bullet lead evidence; on underage drinking; and on uninsurance in America.

We have also released an ambitious plan to reinvigorate education research in the United States through a Strategic Education Research Partnership (Figure 4), run by a separate nonprofit organization, led by John Reed, a member of the panel that devised the plan and presently chair of the New York Stock Exchange.

As in all of the work we do, great care is taken to recruit for each study an outstanding committee that covers the entire range of expertise and viewpoints relevant to the task at hand.

Our aim has always been to bring the truth concerning science and technology to Washington. This truth must be free of any partisan considerations. Evidence that we are succeeding comes from a sense that we often seem to make both sides of a debate somewhat uncomfortable with our reports: each side will generally like some of our conclusions, but not all of what we say.

And even in this volatile election year, the government is continuing to come to the National Academies to ask us a large number of hard questions that need to be answered — such as the high-profile studies just beginning on the Hubble Space Telescope repairs and on the EPA's proposals for U.S. power plant modernizations. I am also pleased that the Department of Agriculture has just asked us to carry out a series of periodic reviews of their research laboratories, a task that we have been suggesting for a long time.

In addition, a significantly revised Office of Management and Budget Bulletin for Peer Review was just released on April 15 for 30 days of further comment; this is an enormously improved document due to extensive feedback from the National Academies and others on the original proposal. In it, the procedures used by our institution are widely referenced as guidance for the peer review of scientific assessments by others.

Our Ambitious New International Agenda

Spreading the Impact of Science through the InterAcademy Council

The InterAcademy Council (IAC) in Amsterdam is an organization that was established in 2000 by the 90 science academies of the InterAcademy Panel to provide science advice to the world. The IAC is governed by a group of science academy presidents from 15 nations, with the founding co-chairs being the president from India and myself. The participation of our Academy in helping to create the IAC was supported by the Eugene Garfield Fund for International Programs.

I am pleased to be able to tell you that the IAC's first major product, the report *Inventing a Better Future: A Strategy for Building Worldwide Capacities in Science and Technology*, was successfully launched at a special meeting of U.N. ambassadors convened by Secretary-General Kofi Annan in New York City

Published in 2003, this report recommends establishing a set of research field sites, in which many teachers and school system leaders interact closely with researchers.

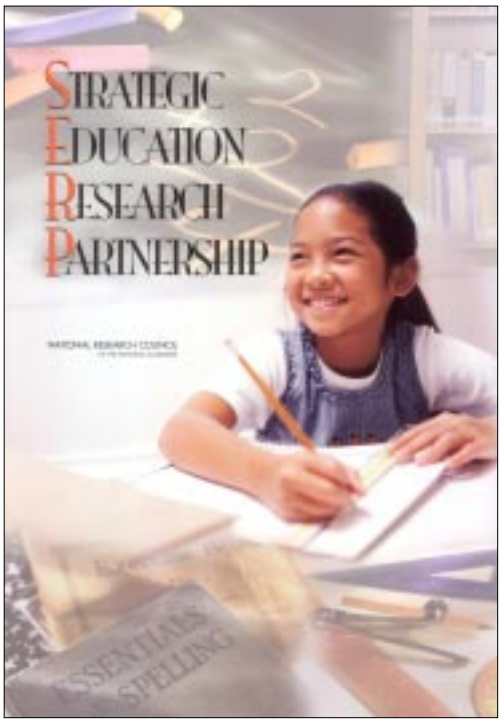

FIGURE 4

on February 5, 2004. Presentations were given by the study panel co-chairs, Ismail Serageldin from Egypt and Jacob Palis from Brazil, plus panel member Mamphela Ramphele from South Africa (Figure 5). As IAC co-chair, I had the honor of formally presenting the report to the Secretary-General at the end of the session (Figure 6).

Inventing a Better Future is energizing a vigorous worldwide movement aimed at building strong institutions for science and technology in every nation. I have a sense that we are at a turning point, with the United Nations, U.N. Development Programme, the World Bank, and other major institutions devoted to international development now recognizing that every nation must have its own capacity in science and technology for its successful economic development. And we are witnessing a new commitment in countries like Brazil, Mexico, India, and China to help less-developed nations, with a series of major new activities in progress. I shall return to the critical issue of capacity building at the end of this talk.

Promoting Sustainability Science

There are many reasons why science and scientists need to acquire a much higher profile everywhere. *Our Common Journey: A Transition Toward Sustainability* report (1999) described one of them: an urgent need to harness new science and technology more effectively if the world's people (nine billion expected in 2050) are to live on an Earth constrained by shared resources. This landmark report emphasized the need for a new interdisciplinary, place-based "sustainability science," one that integrates the social and the natural sciences. In the five years since that effort, we have struggled to find an effective way forward — an effort being strongly propelled by the George and Cynthia Mitchell endowment for sustainability science at the National Academies.

The problem is a large and multifaceted one. It is clear that the past approaches used to spur international development by the World Bank and by national and international development agencies have been inadequate, and that a much more vigorous incorporation of science and technology into all such efforts is long overdue. In fact, I am pleased to be able to announce that, at the request of USAID, the National Academies are in the midst of a major study specifying how science can best be harnessed to support the international development programs of our own government.

It is widely recognized that we need new ways to deliver sustainability science around the world. In many cases, it would be most effective if we could stimulate the local private sector to provide many of the needed science-based services for food production, as well as important services that

FIGURE 5

meet environmental, health, and infrastructure needs.

When I began my job here 10 years ago, I knew almost nothing about either international science or the challenges of economic development in nations that are not yet industrialized. But I have long been fascinated by the success of companies like McDonald's and Coca Cola, which have somehow been able to motivate and train very large numbers of local entrepreneurs around the world, transferring a great deal of useful knowledge through franchising. Why, I wondered, has this franchising mechanism been so effective for establishing local enterprises? Could it not also play a major role in providing agricultural extension help for farmers, in the drilling of wells and provision of safe drinking water, in generating small knowledge-based construction companies, and in the processing of local foods by farm families? Just to name a few examples.

The Challenge of Bottom-up Development

In the United States, we often talk about economic development as a top-down phenomenon. In this model, a person or a corporation with resources will establish a business enterprise and hire employees. Later, some of these employees will accumulate enough resources themselves to start their own businesses; these in turn will create more employment and greater wealth in the community, and so on.

This model may apply to nations like ours. But it is totally inadequate to meet the current needs of a nation like India, where 70 percent of the population live in rural villages, with limited opportunities for education and non-agricultural employment. For other jobs, they are forced to move to cities and often must live in expanding urban slums.

FIGURE 6

Most of the world resembles India, but India has the advantage of having a strong scientific and technical capacity despite its extensive poverty. It is also a very large and diverse nation that provides a fertile test bed for new ideas. If our Academy wants to make a strong contribution to sustainable development through science and technology, it is in nations like India that we should search for models, not in nations like ours.

Many interesting experiments are in progress around the world, and I have been attempting to follow some of them to see what can be learned about effective strategies for attaining the vision elaborated in *Our Common Journey*. This past January, my wife Betty and I made our third visit to the villages of Pondicherry, India, where a non-governmental organization (NGO) founded by our foreign associate M.S. Swaminathan has been deeply engaged in a variety of science-based experiments in rural development (see <www.mssrf.org>).

On previous trips, we had visited the information kiosks in these villages, which connect the otherwise isolated villagers to a wireless Internet service in their local language that provides them with daily market prices, and weather, health, and agriculture

information. We had also followed the development of several science-based enterprises — in which, for example, a small group of landless villagers produces mushrooms or milk for sale.

At the end of each of our earlier visits, Betty and I were left with the feeling that the problem of both long-term sustainability and scale were overwhelming. Perhaps this highly dedicated and uniquely skilled NGO could, with the support of various donors, ultimately affect 20 or 40 villages, with a total population of 100,000 people. But what would happen when its leadership changed, or when the current donors decided to move on to other projects? And, most important, what about the remaining 700 million Indians who live in similar situations elsewhere? The challenge seemed overwhelming and the whole enterprise fragile.

Bring in the Bankers

I was surprised to encounter a completely new element in our last visit. The State Bank of India (Figure 7) is now intimately involved as a partner with the M.S. Swaminathan Research Foundation in each of the village projects that we helped to inaugurate. Some of the projects were dairies, as before, but other groups of villagers had set up small production plants for biocontrol agents.

FIGURE 7

In one example, a group of villagers had established a factory to produce the small parasitic wasp, *Trichogramma*, which deposits its eggs on those of larger insects and destroys them. Some of their product is being used in their own village to replace pesticides and increase plant yields — thus bringing both health and economic benefits. The remaining product is being sold in the market to generate income. And the women involved had begun to train new groups in neighboring villages. Here was a perfect example of the type of science-based franchise for sustainable development that I had been seeking.

The State Bank funded the equipment and supplies needed by each of the groups through loans, and it was our privilege to hand out the checks (Figure 8), some for more than $5,000. The interest rates charged are generally about 20 percent per year, which is much less than the rates of the traditional moneylenders, who may demand 10 percent per month or more.

Is this a public service activity, subsidized by the government? To my surprise I learned that the answer is no. These cooperatively held loans are being made to so-called "Self-Help Groups" — each composed of 10 to 20 villagers who had learned to work together. They are among the bank's best-performing customers, with 95 percent of repayments being made on time.

Through 700,000 Self-Help Groups, about 70 million people have thus far been helped with bank credit in India, with an

average loan per group of about $700. About 90 percent of these groups consist only of women. According to the general manager of the Central Bank of India, these loans are "meant to deliver women from socioeconomic oppression, and empower them through monetary security."

The bottom-up development generated by loans to cooperative groups of the rural poor is a major movement encouraged by the Indian government. It is being stimulated, guided, and monitored by India's National Bank for Agriculture and Rural Development, whose Web site <www.nabard.org> provides guidance on the establishment and evaluation of Self-Help Groups, as well as many other informative details. We need only think back to Jimmy Stewart's role as George Bailey in the 1946 movie *It's a Wonderful Life* — still a holiday classic — to remind ourselves of the important role that the credit provided to ordinary Americans by local banks has had on our own nation's development.

Experiments in Africa

As this example demonstrates, those of us in the United States who have been struggling to find productive ways to link science to sustainability goals have much to learn from experiments in other nations. Another foreign associate of our Academy, Akin Mabogunje, an urban geographer from Nigeria, has played a major role in creating two other prototype examples.

As Dr. Mabogunje recognized, because the low-income workers and craftspeople in Nigeria have no collateral to offer, they lack access to the credit that they need to expand their small businesses. This led to his formation of the first Nigerian "community bank" in 1990, as well as to the establishment of a

FIGURE 8

National Board for Community Banks that he initially headed. A community bank is a local institution, where one's honor and social standing in the community are the key to obtaining a loan. As in the case of the Indian Self-Help Groups, peer pressure takes the place of collateral in insuring that the loans are repaid. Today there are nearly a thousand community banks in Nigeria.

Through an NGO that Dr. Mabogunje started, he has recently helped to catalyze an experiment in sustainable development in the city of Ijebu-Ode. This is a region of about 200,000 inhabitants where 90 percent of the people live below the international poverty line, earning less than one dollar per day. The experiment began with what we would call a "knowledge assessment" (see <books.nap.edu/catalog/9528.html>). First a report was prepared listing the prime opportunities for job creation in Ijebu-Ode, along with the main actors in the socioeconomic life and governance of the city. This led to an extensive city consultation process involving many diverse groups. As a main outcome, a set of strategically selected worker cooperatives were either engaged or formed. Credit was then extended to each of

them for enterprise development.

Pictured here are some of the members of a beekeepers' cooperative (see Figure 9), along with both Dr. Mabogunje and Academy member Robert Kates. Some of the other cooperatives being supported in the city are focused on aquaculture, on women who run local markets, and on cassava production and processing.

Even though no collateral was used to secure these loans, the experiment appears to be a success. The loans are being repaid, and much useful economic activity has been stimulated. It therefore would appear that, with strong preparation and planning, the provision of unsecured credit for cooperative enterprise development can work on different continents, and in both urban and rural settings.

Exploring a New Idea

I now view the banks of this world, with their hundreds of thousands of branches, as a potential major ally for scientists. How might banks spread science-based franchises across the globe, driven by a for-profit motive?

As a start, I suggest that a group of academies launch an international project to analyze, evaluate, and provide widespread knowledge support for the world's top 100 science-based franchises — defined as those that have proved to be truly useful for small enterprise development somewhere in the world, while also serving sustainable development goals. By targeting banks and the NGOs in developing nations as the main customers for this effort, we should be able to recruit important new audiences for the sustainability science goals outlined in *Our Common Journey*, while also generating a much wider appreciation around the world for what science can do for humanity.

FIGURE 9 Photo includes Akin Mabogunje (second from right) and Robert Kates (fourth from left).

Announcing a New Program in Africa

I am extremely pleased to be able to announce today, for the first time publicly, that the Bill & Melinda Gates Foundation has just provided a $20 million grant to the National Academies to work on institutional capacity building in Africa.

Over the course of the next decade, we will be working closely with the academies of science in three African nations, as well as with a network of all our counterparts in Africa. Our long-term goal is to help each academy attain the abilities it will need to become an effective, independent national voice for science that is useful to — and respected by — its own government and the press of its nation.

Our three national partners will be selected late this year. We will begin by carrying out a joint study with each academy on a health topic requested by its government. A series of subsequent studies and workshops will then be carried out by the African academies themselves, with only mentoring from us.

We view this entire project as an important way to help connect the scientific community in each of the selected nations to

national needs and goals, as well as a great learning opportunity for the American scientists. We will work closely with our African colleagues as we proceed together in this new endeavor (see <www4.nationalacademies.org/news.nsf/isbn/04192004>).

Meeting the Challenges Ahead

As I see it, there are a number of clear challenges for those of us in the United States who would like to see science — and a science culture — spread much more widely around the world.

First, we must come to respect and support a wider range of sciences than is traditional for our typical university science departments.

Second, we must work to bring many more of our scientists and our students into close contact with the potential ways in which their expertise can make a difference for the 85 percent of the world's people who live in developing nations.

Third, we must work to enact the vision in the InterAcademy Council report *Inventing a Better Future.* This will require that we focus much more intensively than we have in the past on helping our colleagues in developing nations build and maintain institutions of excellence in science and technology.

Only local institutions are likely to have the understanding, persistence, and credibility needed to provide truly effective guidance to their people and their governments. Thus, it is impossible for me to imagine how any of the small enterprises that I saw in India could be maintained by "flying in" advice from America. The women producing biocontrol agents in Pondicherry were initially trained at a university in Chennai, several hours away. On occasion, something will go wrong with their production process, but for troubleshooting they have access to scientists who speak Tamil, their local language, through the information kiosk in their village. In turn, those scientists can rely on the Internet to instantaneously connect them to the information sources and to the other scientists that they may need to help the women, even if these are located on the opposite side of the globe.

Science has become a truly international endeavor that is crucial for the world's future. New communications technologies now allow science to reach everywhere. And everyone needs science—from a doctor in America seeking a cure for a deadly disease — to the poorest of villagers looking to lift themselves out of poverty.

In short we need to bring all nations to the great truth — which we learned long ago in the industrialized world — about the critical role of science in industrial and social development. This truth was beautifully captured and inscribed on the dome of the Great Hall of our Academy 80 years ago.

So in ending, I would like to recite this wonderful phrase — and ask you to please join me if you wish:

> *Here's "to science, pilot of industry, conqueror of disease, multiplier of the harvest, explorer of the universe, revealer of nature's laws, eternal guide to truth."*

NOTE: The text of this speech, with direct links to the full text of cited reports, is available on the Academy's Web site at <www.nas.edu/nas/2004address>.