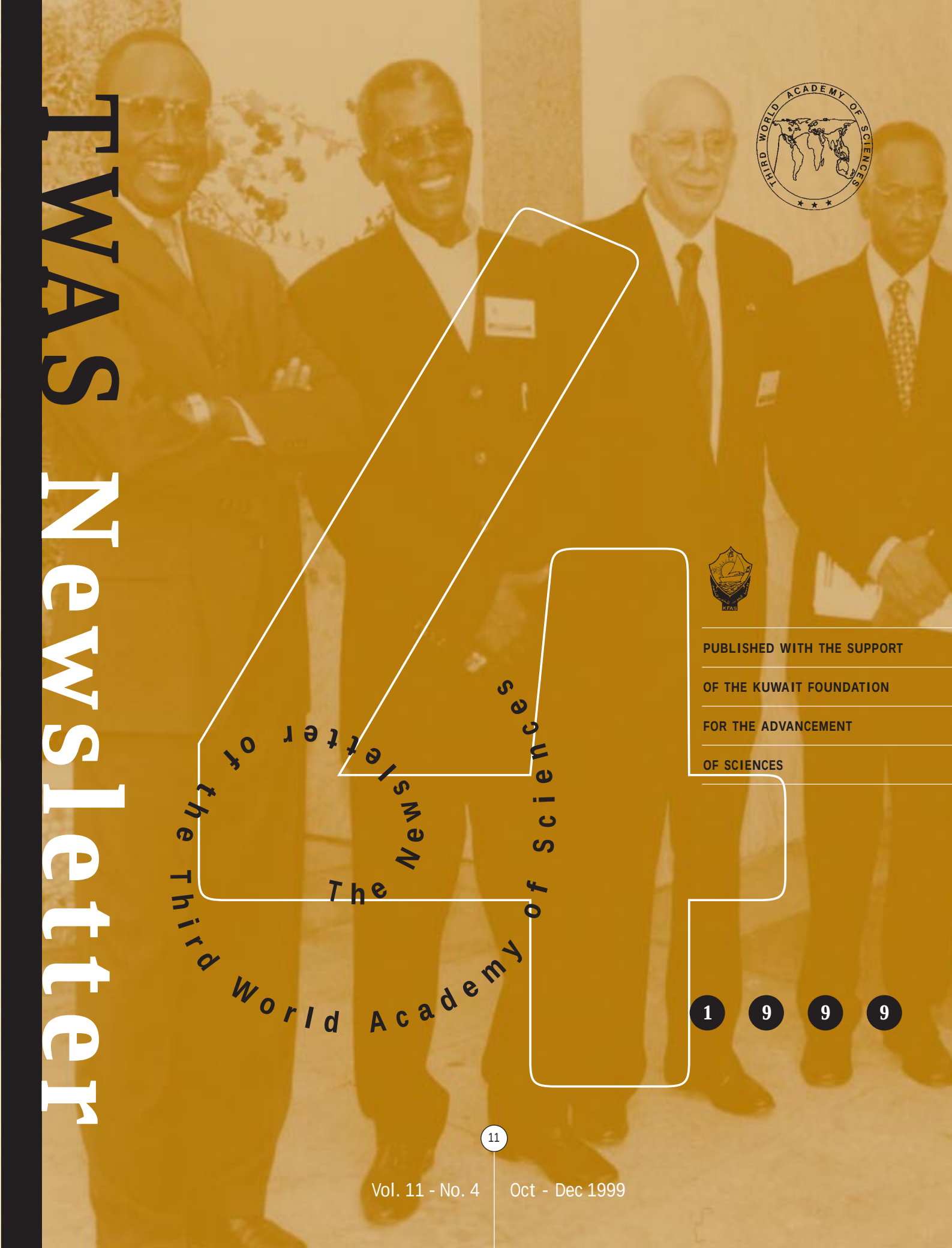
TWAS Newsletter



The Newsletter of the Third World Academy of Sciences

PUBLISHED WITH THE SUPPORT
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FOR THE ADVANCEMENT
OF SCIENCES

1999

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EDITOR'S NOTE

At Dakar

Is it possible to adequately describe in a 32-page newsletter a week-long event that included more than 100 presentations from prominent research scientists and scientific policy makers from the around the world? The short answer is no. The slightly longer answer is that we will give it a try anyway.

In the following pages of this edition of the TWAS Newsletter*, we present an overview of the major activities that took place in Dakar, Senegal, from 21-26 November, during the 7th General Conference and 11th General Meeting of the Third World Academy of Sciences (TWAS), the 6th General Meeting of the Third World Network of Scientific Organizations (TWNSO), and the 4th General Meeting of AFRISTECH.*

The focal point of discussions at the conference was science and sustainable development in Africa—and that will be the focal point of this edition of the newsletter as well. Readers will hear from the president of Senegal on the prospects for science-based development in his own country and other sub-Saharan African nations; from Thomas Odhiambo on efforts to launch an African renaissance that will join science, culture and development to improve the continent's material and spiritual well-being in the next century; from Calestous Juma on the role biotechnology could play in upgrading the scientific and technical capabilities of developing countries in general and sub-Saharan Africa specifically; from a host of ministers of science, technology, researchers and educators who engage in a broad-based discussion on the future of science policy in Africa; and from Felix I.D. Konotey-Ahulu, who assesses the often-hidden contributions that African anthropogenetics have made to world medicine, and how these contributions could

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TWAS NEWSLETTER
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become even more significant in the future if Northern medical practitioners learn to concentrate their efforts on their patients instead of their own research agenda.

Given the sprawling nature of the conference and the space constraints of the TWAS Newsletter, *it would be impossible to give our readers a full sense of the issues that were discussed and debated. Such a comprehensive portrait of the conference activities will be found in the proceedings, which are scheduled to be published next year. What we can do here is to provide you with a sampling of conference activities, ranging from its philosophical musings to its social science assessments to its detailed investigations of scientific research.*

The broad range and high quality of the presentations and discussions in Senegal, from a scientific point of view, made this conference the strongest in TWAS's history. Indeed the presentations and discussions in Senegal serve as testimony both to the increasing strength of scientific research throughout the developing world and the Academy's growing reputation for excellence. We look forward to advancing these trends even further at TWAS's 12th General Meeting, which will take in Tehran, Iran, in 2000, and TWAS's 8th General Conference, which will take place in Bangalore, India, in 2001.

EDITOR'S NOTE

COMMENTARY

SCIENCE IN SENEGAL

In our age, science and technology determine the ability of a nation to control its destiny. Senegal's newly formed government realized this truth soon after independence in 1966 when it embarked on an ambitious programme for science-based development. Our initiatives resulted in some progress over the next 20 years. But political instability during the mid 1980s caused us to largely abandon our efforts. For 10 years, between 1986 and 1995, Senegal was without a ministry of science and technology. Then, in 1995, Senegal re-established this ministry, reconfirming the government's commitment to place science and technology at the centre of its economic development efforts.

What steps do we plan to take now that we have re-instituted and strengthened our ministry of science and technology? First, we plan to bolster existing institutions such as the *Institut Fondamental d'Afrique Noire Chiekh Anta Diop*, the *Institut Sénégalais de Recherches Agricoles* and the *Institut de Technologie Alimentaire*. We also plan to give additional support to the University of Senegal to enhance its teaching and research capabilities. The university, after all, is home to the nation's largest contingent of scientists and technologists. Second, we plan to encourage both our research institutes and universities to pursue activities relevant to our nation's economic, social and environmental well-being. Basic research will remain a prominent part of the agenda but we will seek to direct studies toward issues of relevance to our people: agricultural commodities; energy production; meteorology; and communication technologies. Third, we will seek to upgrade the working conditions of our scientists, not only by investing additional resources in facilities and equipment, but by allowing scientists to organize collectively to express their concerns. Fourth, with the help of the French government, we will try to increase the presence of foreign researchers in our institutes and universities. Science is an international enterprise, and we recognize that efforts to boost our scientific know-how will be greatly enhanced by opening our doors to scientists from around the world. We also think that foreign scientists could learn a great deal about science in the developing world from their experience here in Senegal.

Our efforts have already yielded promising results. For example, domestic scientific research has led to the discovery and distribution of higher yielding crop varieties that are also better suited to our climatic conditions; improved bovine breeds that produce greater quantities of milk and meat per unit of feed input; more detailed knowledge of the biochemical makeup of our domestic plants that we hope will prove useful in uncovering and extracting valuable active agents used in the development of new drugs; and the creation of a database cataloguing potential sources of solar and wind energy that we anticipate will become a valuable part of our energy mix in the future.

Despite the progress we have made, we realize that we have much more work to do before we can be sure that we have created a strong and sustainable foundation for science-based development. For example, only one third of our adult population is literate, and juvenile delinquency and drug addiction remain serious problems; more than half the investment in science and technology in Senegal comes from foreign partners, which makes it difficult for us to control our research agenda; private investment in science and technology in Senegal has never exceeded 2 percent of the total, which means that the government must shoulder virtually all of the responsibility for this effort; over the past number of years, the Senegalese government has invested about 1 percent of its annual budget in science and technology, an enviable figure compared to other developing countries; yet, the government's total annual budget remains modest, and that translates into very modest expenditures for scientific research. Moreover, all these investments have been continually eroded by the devaluation and weak standing of Senegal's currency, the Central African Franc.

Since 1995, Senegal's gross domestic product (GDP) has grown on average more than 5 percent a year. This growth is due to several factors: economic liberalization; low inflation and debt; regional cooperation; and an expansion of the nation's transportation and communication systems.

The role of science and technology in these efforts, however, cannot be underestimated. In fact, Senegal's long-term economic growth depends in no small measure on adequate, sustainable funding for science and technology.

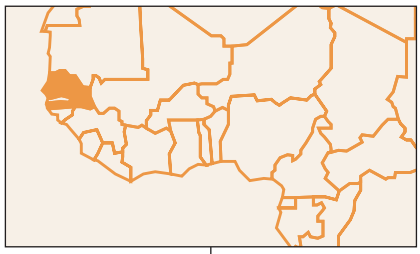
Our situation parallels the situation found in emerging developing countries throughout the world. The critical issue is this: How do we attend to our immediate economic and social problems without undermining our prospects for future growth? Answers to this perplexing issue are not easy, but this much is clear: foregoing investments in science and technology will only add to the impoverishment of people in the developing world, and in the long run fail to provide them with the skills and tools they need to improve their capacities to build healthy and productive societies.

Abdou Diouf
President
Republic of Senegal

COMMENTARY

CONFERENCE IN SENEGAL

Week-long event explores a wide-range of issues related to science and development. Declaration calls for the creation of scientific panels to advise governments in the South.



More than 300 scientists from 60 nations, including some 8 ministers of science and technology from developing countries, met in Dakar, Senegal, from 21 to 26 November, to discuss the use of "science and technology for sustainable development in Africa."

The occasion marked the 7th General Conference and 11th General Meeting of the Third World Academy of Sciences (TWAS), the 6th General Assembly of the Third World Network of Scientific Organizations (TWNSO), and the 4th biennial meeting of AFRISTECH, a foundation that supports the development of science and technology in Africa. Conference sponsors included the French Academy of Sciences; the International Development Research Centre (IDRC), Canada/Senegal; Norwegian Development Agency (NORAD); United Nations University (UNU), Japan; World Meteorological Organization (WMO), Geneva; Organization of Islamic Conference (OIC) Standing Committee on Scientific and Technological Cooperation (COMSTECH), Pakistan; and the Commission on Science and Technology for Sustainable Development in the South (COMSATS), also in Pakistan.

The event concluded with the unanimous approval of the Dakar Declaration that hailed the importance of science and technology in addressing issues of critical importance to Africa and the developing world. The Declaration asserted that science and technology must be put to use to address such critical issues as "poverty eradication, health, peace, sustainable development and environmental protection." The Declaration also outlined responsibilities for governments, scientific communities and international funding agencies in the promotion of science-based development, including the need to improve science education, boost investments in the scientific infrastructure, devise plans for advancing information technologies, expand opportunities for female scientists, protect international property rights and establish biosafety regulatory statutes.

The Declaration then listed a six-step action plan, which called for:

• Creation of an *international panel of scientific experts* in such critical areas as information technology, biodiversity and new and renewable energies to advise governments in Africa and throughout the developing world on science and technology issues.

• Development of *centres of excellence* in Africa and the developing world in which world-class basic research could be pursued through South-South and North-South cooperation.

• Establishment of *regional and national innovation centres* dedicated to exploring the relationships among the basic sciences, technology, policy and management in Africa and throughout the developing world.

• Promotion of *cooperation among scientists of African origin* regardless of where they live to foster investigations of issues of importance to Africa.

• Increasing the *participation of women in the study of science* in Africa and throughout the developing world by working with such organizations as the Third World Organization for Women in Science (TWOWS).

• Preparation of a background paper analysing challenges related to the forging of *partnerships between the scientific community and private sector* in Africa and throughout the developing world.

"The Dakar Declaration," notes José I. Vargas, President of TWAS and TWNSO, "captured two of the main themes of the conference: first, the on-going need for the creation of co-operative frameworks that extend across traditional boundaries, whether those boundaries are defined by geography, politics, economics or academic disciplines; and, second, the need both for science and scientists to play more active roles in the creation, implementation and assessment of economic development strategies. We plan to report on the progress made on these fronts at the next general conference of TWAS, scheduled to take place two years from now."

TWAS'S CURRENT MEMBERSHIP

TWAS's current membership totals 512, including 412 Fellows from 62 countries in the South and 100 Associate Fellows from 14 countries in the North. In 1999, TWAS received 95 nominations. At the Senegal meeting, the TWAS Council agreed to place 36 of these 95 nominations on the 1999 membership ballot, which has been mailed to TWAS's current members. The list includes five women, the largest number of women ever included on a TWAS membership ballot. Nominees, who are elected to the Academy, will be honoured at the TWAS's 12th General Meeting to be held in the autumn of 2000.

Beyond the Dakar Declaration, the conference honoured and showcased the broad-based scientific excellence currently being pursued across the South. Activities during the week-long event included:

• An opening address by H.E. Abdou Diouf, President of Senegal, in which he welcomed conference participants and spoke of the week-long event as an unprecedented opportunity for Senegal to display its recent advances in science and technology and to learn about efforts in science-based development taking place throughout the developing world.

• The induction of 39 TWAS members elected in 1998. The Academy's membership now totals 512, including 412 Fellows from 62 countries in the South and 100 Associate Fellows from 14 countries in the North.

• Lectures by the recipients of the 1998 TWAS awards, including discussions related to superconductivity (B.S. Shastry, India); protein synthesis (G. Guarneros Pena, Mexico); biphasic solvent response in liquids (B. Bagchi, India); chaotic dynamics (M. Viana, Brazil); and African contributions to world medicine (F.I.D. Konotey-Ahulu, Ghana).

• Lectures by the recipients of the 1998 TWNSO awards, including discussions related to solid state nuclear track detection (H.A. Khan, Pakistan); molecular biotechnology and food production (O. Paredes-López, Mexico); technical innovations in India's micro-enterprise leather industry (T. Ramasami, India); and shelterbelt research for curbing soil erosion and improving timber production in China (L. Ji, China).

• Invited lecture by one of the chief conference organizers of the World Conference on Science (WCS), which took place in Budapest, Hungary, last summer (M. Iaccarino, UNESCO, Paris). The lecture focused on follow-up activities in science and technology, particularly in developing countries, that have occurred over the past six months. WCS organizers are hoping that the conclusion of the week-long event marked the beginning, not the end, of an on-going process to assess the role of science and technology in our increasingly "globalized" world.

• Invited lecture by C.N.R. Rao examining the dramatic advances

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TWAS
7TH GENERAL CONFERENCE

TWAS
11TH GENERAL MEETING

TWNSO
6TH GENERAL MEETING

AFRISTECH
4TH GENERAL MEETING

that have taken place in the past 10 to 20 years enabling scientists to "see" what has never been seen before: the structure of atoms and molecules. What scientists have uncovered, Rao noted, is the "beautiful" patterns in things both "big and small." The additional basic knowledge that scientists have acquired about materials has enhanced our understanding of their properties. That, in turn, has sparked the development of new technologies. Rao ended his talk with an impassioned plea for developing nations to continue to invest in basic science not just for the sake of scientists but for the sake of the future well-being of their societies. Each country, he maintained, must find a niche of scientific excellence if it hopes to succeed in the 21st century.

• An overview of the current state of science and technology in Senegal focusing on the creation of the Senegalese Academy of Sciences and Technology, which was officially launched at a conference ceremony that featured the selection of the Academy's founding members. Senegal's Minister of Science and Technology, B.M. Daffe, viewed the creation of the Academy as a signature event marking the emergence of the nation's scientific community as a key player in his nation's efforts to pursue a sustainable path to development.

• A panel, consisting of 9 ministers of science and technology from developing countries, which examined the state of science-based development in the South. The panellists agreed that sustainable economic and social progress in Africa and the developing world depended on two factors: a nation's willingness to make the necessary financial commitments for building adequate capacities in science and technology, and the ability to create regional and international networks of cooperation enabling the nations of Africa and the developing world to learn from one another. They also expressed concerns that advances in science and technology take place within the fabric of traditional societal values and not serve as a pretext for shredding the deeply woven cultural ties that unite a people.

• A discussion outlining the initiatives of the Global Environment Facility (GEF) led by the chair of GEF's Scientific Technical and Advisory Panel or STAP (M. Gadgil, India). GEF is an organization that was chartered during the 1992 United Nations Conference on Environment and Development (the Rio Earth Summit) for the purposes of protecting the global environment and promoting sustainable economic growth in both developing countries and countries with economies in transition. Issues of special interest to GEF include biodiversity, climate change, the state of international waters and land degradation The discussion focused on GEF's desire to more actively engage the scientific community, particularly the scientific community in the South, in its projects, and the role that TWAS could play in identifying issues of concern—as well as institutions and individuals who could effectively address those concerns.

• A plenary lecture on biotechnology and sustainable agriculture in Africa (C. Juma, USA), which emphasized the need for Africa to establish its own agenda for the use of biotechnology as a prerequisite for breaking the stranglehold that Western agribusinesses, especially those headquartered in the United States, currently have on the technology and its applications. Juma urged African nations, and nations throughout the South, not to turn their backs on this promising technology but to take the necessary steps to ensure that it is applied to agricultural and pharmaceutical products that benefit their societies. He also noted that biotechnology could prove instrumental in helping developing nations create the science and technology infrastructure and public/private sector links that

1999 PRIZES

The Third World Academy of Sciences announced the recipients of the 1999 TWAS Awards in Basic Sciences: E. Cavalheiro (Brazil) in basic medical science; R. Gadagkar (India) in biology; D. Ranganathan (India) in chemistry; S. Martinez (Chile) in mathematics; and N.B. Ming (China) in physics. The TWAS Council agreed to award the 2000 TWAS Medal Lectures to: F.I.B. Kayanja (Uganda) in the biological sciences; Y.X. Lu (China) in the engineering sciences; and Y. Sobouti (Iran) in the physical sciences.

will likely be the keys to economic success in the next century. The lecture was followed by a workshop, chaired by K.A. Malik (Germany), that explored both the opportunities and risks posed by biotechnology for the developing world, particularly in light of the controversies surrounding the ownership of intellectual property rights.

• A plenary lecture on the status of health sciences in the tropics (K. Dellagi, Tunisia), which examined the new strains of host-parasite diseases emerging throughout the tropics and the medical responses that have been designed to combat them. Dellagi suggested that such efforts could have far-reaching impacts on disease management not only in Africa but throughout the world. The lecture was followed by a workshop, chaired by I. Diop-Mar (Senegal) that explored the wide-ranging medical research currently being conducted in Africa and throughout the developing world that explores public health issues in relationship to a nation's economic and social well-being.

• A wide-ranging, impassioned talk by T.R. Odhiambo (Kenya), describing the largely African-based forces seeking to launch an African renaissance movement. Odhiambo gave his presentation in honour of his selection as the 1999 TWAS Abdus Salam Medallist for Science and Technology. Odhiambo noted that the initiative, which was launched in earnest earlier this year with the creation of the Renaissance Foundation, will seek to form a broad framework of analysis and action, led by experts of African origin, that is designed to address economic, environmental and social issues of concern to Africa. The Renaissance Foundation, Odhiambo declared, will propose solutions that not only draw on state-of-the-art scientific knowledge and technical skills but that are connected to Africa's cultural values and mores. A follow-up workshop, chaired by R. Lotsberg (Norway), examined a critical aspect of Odhiambo's talk—namely, strategies for financing innovation and new partnerships for technological development in the developing world.

More than 300 scientists from 60 nations met in Dakar, Senegal, from 21 to 26 November

• A discussion focusing on devising a new social contract between science and society (T. Strand, Norway) that will engage the global community in science-based issues that are relevant to both the developed and developing world. Such an effort is essential not only for the future well-being of the two-thirds of the world's population living in the developing world but for the future of well-being of science, which must address issues of relevance to people if it hopes to retain the continued support of individuals and institutions both in the South and North. A follow-up workshop, chaired by S. Ghose (India) explored the issue of scientific literacy in Africa and the Third World and discussed potential programmatic partnerships between the South and North that would rely on print and broadcast media to help raise the level of scientific literature among young people in the developing world.

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• A workshop describing the current status of efforts to launch a Millennium Ecosystem Assessment, chaired by A.H. Zakri (Malaysia) and Walter Reid (USA). The effort will seek to improve ecosystem management by bringing information and knowledge on ecosystem goods and services to bear on policy and management decisions. In addition, the effort will seek to build capacity at the local, regional and national levels for undertaking integrated ecosystem assessments. The global component of the Millennium Ecosystem Assessment will establish baselines for future assessments, help meet the information needs of international conventions, establish methodologies for integrated ecosystem assessments and raise public awareness about the importance of ecosystem goods and services. Panel organizers noted that seven members of TWAS were on the steering committee of the Millennium Ecosystem Assessment and urged the Academy to endorse efforts to get the Assessment off the ground and running. TWAS, in turn, urged those working for the creation of the Millennium Ecosystem Assessment to identify ways in which Academy members and networks could be fully engaged in the process.

• A plenary lecture (G.O. Ajayi, Nigeria) analysed the impact that 21st century information and communication technologies are having on education and culture in Africa. A follow-up workshop, chaired by G.O. Ajayi (Nigeria), focused on the need for developing countries to improve their information and communication technology infrastructures to take full advantage of emerging information technologies. Workshop participants emphasized the value of national and regional partnerships and joint public/private-sector initiatives. Strategies based on such co-operative ventures, they contend, should prove particularly fruitful in the development of information networks.

• A workshop on new and renewable energy, chaired by T. Achour (Tunisia) that examined the potential role of new and renewable energy in strategies for sustainable economic growth in the developing world.

• A workshop, chaired by M. Virasoro (Italy), discussed the current state of basic research in Africa and throughout the developing world. Participants emphasized that basic research plays an instrumental role in efforts to develop strategies for sustainable growth by creating the intellectual foundation necessary for the adoption of effective technologies. That is why participants called on each nation to develop a critical mass of meritorious scientists to ensure the presence of a scientific establishment within their borders. To achieve this goal, workshops participants agreed that nations must nurture an appreciation for science among its citizens; display a consistent commitment to science; encourage cooperation between the research community and industry; and devote between 1 and 2 percent of their gross domestic product (GDP) to research and development.

The conference's closing ceremonies, which took place on Friday, 26 November, were highlighted by addresses by Senegal's Minister of Science and Technology, B.M. Daffe; A.L. Ndiaye, President of AFRISTECH, and José I. Vargas, President of TWAS. All expressed hope that the end of this week-long event marked the beginning of a continual process of scientific investigations and technological applications that would lay the foundation for sustained economic and social progress throughout Africa and the developing world. ■

12TH GENERAL MEETING

The 12th General Meeting of the Academy will take place in Tehran, Iran. The Iranian delegation, led by the Minister of Culture and Higher Education, M.N. Moin, generously agreed to host the meeting during the Senegal meeting. Among the major topical themes to be explored in Tehran are the use of science—and, more specifically, scientific research—as a tool for overcoming the cultural divides that separate nations, and the central role that information technologies will play in advancing science and technology in the developing world. The conference is scheduled for October 2000. Meanwhile, Bangalore, India, has been designated as the site of the 8th General Conference and 13th General Meeting of TWAS, which will be held in 2001. President-Elect C.N.R. Rao, who will succeed TWAS's current president José I. Vargas in 2000, will preside over that meeting. China will serve as the site of the 9th General Conference and 14th General Meeting of TWAS. That meeting, which will take place in 2003, will be hosted by the Chinese Academy of Sciences.

AFRICAN RENAISSANCE

Now that colonialism and the cold war are history, African leaders are eager to launch a continent-wide renaissance that melds traditional values with modern science.

ALTHOUGH NAMDI AZIKIWE, THE GRAND OLD MAN OF NIGERIA'S POLITICS, FIRST RAISED THE PROSPECT OF A "RENASCENT AFRICA" IN 1938, AND KWAME NKRUMAH, THE FOUNDING FATHER OF MODERN GHANA, SPOKE OF A "BLACK RENAISSANCE" IN THE 1950S AND 1960S, OVER THE PAST TWO YEARS, THABO MBEKI, PRESIDENT OF SOUTH AFRICA HAS TRAVELLED WIDELY IN AFRICA AND AROUND THE WORLD POPULARIZING THE IDEA OF AN "AFRICAN RENAISSANCE."

In an address he gave on the occasion of the launching of the African Renaissance Institute (ARI) in the Presidential Guest House in Pretoria, South Africa, on 11th October 1999, in the presence of the ARI Council of Elders comprised of former presidents Nelson Mandela, Sir Ketumile Masire of Botswana, A. Pereira of Guinea Bissau, Toumani Toure of Mali and the late Mwalimu Julius Nyerere (represented by the Tanzanian Ambassador to South Africa), and 500 other intellectuals, community leaders, business people, and scientists, Mbeki referred to a shared vision of African unity and solidarity, of African development and renewal, and of returning this vision to the peoples of Africa to realize a popular movement for the African renaissance. Such a movement, in his view, would embrace political organizations and governments throughout the continent—the intelligentsia, professionals, traditional leaders, business people, trade unionists, women, youth, media specialists, drawing them into "the popular struggle for Africa's rebirth."

Conditions now favouring an African renaissance are, first, the complete liquidation of the colonial system in Africa with the liberation of South Africa; recognition by the people of Africa, including the middle strata, of the bankruptcy of neo-colonialism; and less jostling among the major powers for spheres of influence in Africa as a result of the end of the Cold War and the accelerating pace of globalization.

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In this context, Mbeki believes that the continent shares a common destiny, having led to the evolution of human life 1.5 million years ago, and having created and hosted leading centres of learning, the arts and technology in ancient times. But more recently having experienced epochs of trauma, "each one of which has pushed her peoples deeper into poverty and backwardness."

Slavery robbed the continent of its healthiest and most productive inhabitants; imperialism and colonialism led to the rape of Africa's natural resources and destruction of traditional agriculture and food security; and neo-colonialism spurred both a global economy in which Africa was a subservient participant and the emergence of predatory national elites who joined the dominant global forces to mercilessly exploit the continent and burden it with a level of international debt that is unlikely to be repaid in the foreseeable future.

The most crucial element in the African renaissance movement will be the mobilization of skilled and talented Africans in and outside Africa.

To counteract the endless difficulties stemming from these epochs of social and economic trauma, ARI, whose headquarters is in Gaborone, Botswana, has outlined an ambitious agenda to establish:

the most effective way of mobilizing and networking Africa's human resources, intellectual wealth and enterprise for an African renaissance in the third millennium. It is designed to serve as a vehicle for Africa's thinkers, researchers, and development workers in all walks of life, across barriers of language, religion, and geographical borders, who are motivated by the quest for Africa's survival, recovery, and sustainable development.

A small secretariat co-ordinates programme activities and works closely with the (1) council of elders, comprised of former heads of state and government who have pioneered development initiatives in their own countries; (2) council of patrons, comprised of current heads of state and government who are spearheading transformational programmes in their countries; and (3) leaders of ARI's national chapters.

The institute's core programmes are organized under commissions led by executive directors who are located throughout the continent. The commissions are focusing initially on the following issues:

- Human Resources
- Science and Technology
- Economic Recovery and Enterprise Development
- Peace and Governance

- Infrastructure and Communications
- Human Settlements, Energy, and the Environment
- Food, Nutritional, and Health Security
- Cultural Rebirth

ARI's finances will operate under a trust fund derived largely from African sources, including those in the Diaspora. The most crucial element in the African renaissance movement will be the mobilization of skilled and talented Africans in and outside Africa in key social, economic, entrepreneurial and scientific fields who will lead efforts for the transformation of African societies.

BRAIN-DRAIN

The inability to mobilize Africa's brainpower represents the most glaring failure in policy-making and strategic decision-making in Africa today. The scope of the brain-drain and out-migration of skilled scientists, engineers, doctors, technologists, and other professionals from Africa to other continents has sapped the potential for Africa's development in the near-term.

... roughly 100,000 high-level experts, equivalent to the estimated number of foreign experts working in Africa, were part of Africa's brain drain during the 1990s.

Three distinct groups form this flood of out-migrants:

- Distressed scientists and scholars from Africa who, through circumstances beyond their control, have seen their world fall apart to the extent they can no longer pursue their scientific, scholarly or professorial careers. Such victims often find their lives reduced to a struggle for survival.
- African scientists, scholars and students trapped in terrible situations outside Africa, such as the cataclysmic changes taking place in the Balkans or the former Soviet Union.
- Expatriate scientists and scholars from both Africa and the Diaspora seeking to contribute to the continent's renaissance while retaining their permanent residence or citizenship.

Studies indicate that roughly 100,000 high-level experts, equivalent to the estimated number of foreign experts working in Africa, were part of Africa's brain drain during the 1990s.

The market in Northern industrialized countries for skilled scientific and technological professionals from Africa and the South as a whole continues to grow. Meanwhile, international discussions during the 1960s and 1970s for stemming the brain-drain have not borne any tangible fruit. Such modest initiatives sponsored by the United Nations Development Programme (UNDP) and European Union (EU) as the Return of Talent programme have prompted just 600 high-level Africans to resettle in their countries of origin since the programme's launching in 1983.

The crux of the matter is not that Africa's out-migrants should return and resettle in their countries of origin. Rather, out-migrants should emotionally, spiritually and intellectually engage in highly strategic and productive work of significance to Africa.

Africa must never harbour the illusion that other governments and other peoples will finance their rebirth, renewal, and transformation. That's asking too much of human nature. Indeed we have many examples of the negative attitudes that the rest of the world has taken to global efforts to rescue Africa from its technological backwardness. For instance, both the first Industrial Development Decade for Africa, 1970-1979, and the subsequent one, 1980-1989, sponsored by the United Nations Industrial Development Organization (UNIDO) passed without leaving any visible footmarks signalling the technological advancement of the continent. Similarly, the great expectations spawned by the United Nations Conference on Science and Technology for Development, held in Vienna in 1979, and the elaborate financing mechanisms agreed upon for follow-up actions, were never realized because the funds promised by industrialized countries never arrived.

These and other failed promises make it clear that foreign charity will never propel Africa to a modern, industrial status. That goal, and the work required to achieve it, must be designed, financed, and accomplished by Africa itself.

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S&T'S PROMISE

Japan has become the world's second largest industrial economy due to its systematic efforts over several generations to transform its industrial base by investing in education, internalizing technological innovations, and advancing its own domains of advanced S&T and competitive export-led marketing. South Korea, Taiwan, Singapore, Venezuela, and Brazil are hot in pursuit of the same industrial transformation, having entered such advanced domains of S&T as electronic communications and information technologies, satellite and engineering, robotics and biotechnology.

For African nations to emulate such success, they must bank on their own spirit of resilience, which has triumphed over the ravages left behind by 500 years of slavery, imperialism and neo-colonialism.

African nations must engage all their sons and daughters skilled in science and technology, entrepreneurship and marketing, production and processing, whether in Africa or the Diaspora, and encourage them to become involved in Africa's renaissance. Let the scientists and engineers, experts and specialists, communicate S&T to the lay public—because it is necessary for all Africans to become literate in all aspects of modern S&T, its products and services, and its intimate influence on our material lives—and because advances in S&T have become ever-more dependent on the public for funding.

Taking this highly spiritual and inclusive route to Africa's rebirth, renewal and industrial transformation requires confidence in Africa's distinctive vision of its destiny. Africa needs to follow its own path to divine-driven, science-led, and service-oriented renaissance, with its heritage of community-based solidarity, diversity of culture, and unique notions of human well-being.

For Africa to implement a science-led renaissance requires more than S&T—however innovative. It requires more than political will—however development-driven. And it requires more than venture capital—however globally oriented.

What the African renaissance requires more than anything else is the emotional commitment and spiritual conviction that Africa is evolving a new human soul shorn of the past epochs of foreign-engineered trauma and that the material freedom resulting from S&T will free the human soul to explore the limitless horizons that are part of its destiny.

If this becomes the millennial ethics of the African people, it will constitute a new miracle in the annals of human history. Speaking of miracles in a modern scientific forum should not stir any surprise. In Frederick Trinklein's book, *The God of Science*, the University of Oslo professor of physics, Ole Kristoffer Gjotterud, is reported to have said of miracles:

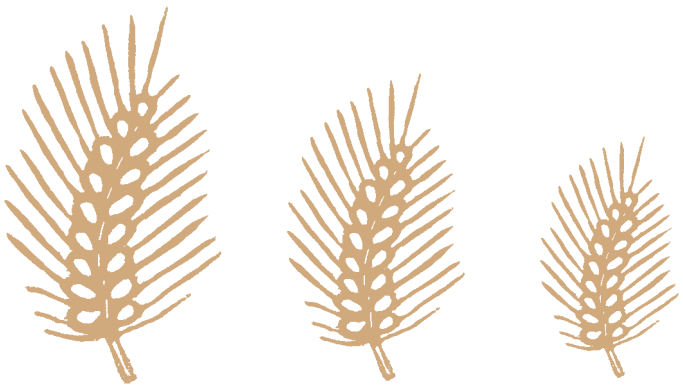
> *I would be very careful about disbelieving the witnesses of miracles, because then I have to conclude that they are lying. I would stay away from any explanation. Just accept it as a witness. I think this is the attitude of science, to be open-minded and not to close the world down and say things are impossible. I think it is an anti-scientific attitude to conclude that things are impossible.*

Let the African renaissance miracle begin to manifest itself as we begin the new millennium—in creating wealth, in nurturing a culture of peace and serenity, and in enhancing the process of human evolution to a status of unquestionable brotherhood and solidarity. Only then will our surviving the genocidal inhumanity of the second half of the second millennium have everlasting meaning. ■

Thomas R. Odhiambo
Honorary President
African Academy of Sciences, Nairobi
Managing Trustee
Research and Development Forum for Science-Led Development in Africa (RANDFORUM), Kenya

AFRICAN BIOTECHNOLOGY

Using safe biotechnology to meet Africa's challenges requires policies linking innovation, enterprise and trade.



AFRICA'S AGRICULTURAL PRODUCTIVITY HAS BEEN AFFECTED BY SUCH PERSISTENT ECOLOGICAL CHALLENGES AS POOR SOILS AND INADEQUATE RAINFALL, WHILE AFRICA'S PUBLIC HEALTH HAS BEEN PUT AT RISK BY THE SPREAD OF SUCH DISEASES AS MALARIA, YELLOW FEVER, LEISHMANIASIS, AND NOW HIV/AIDS.

The good news is that these challenges can be met by applications of existing technologies. However, research and development (R&D) efforts around the world have rarely focused on issues related to tropical agriculture and public health.

While the safe use of biotechnology could potentially address the challenges that Africa faces in these two critical areas, the private sector in industrialized countries has never had sufficient incentives to develop crops and drugs for tropical conditions.

The same scenario arises in the medical sector where R&D has focused on industrialized diseases while paying scant attention to tropical diseases. For example, the Welcome Trust estimates that world-wide research expenditures to combat malaria, which kills up to 2 million people annually, total just over US$80 million a year, a fraction of the expenditures spent on such diseases as cancer and asthma. Again, given the low income levels and purchasing power of potential clients, the private sector does not receive adequate incentives to invest in drugs to fight such tropical diseases.

AGRICULTURAL PRODUCTIVITY

African countries have identified agricultural production as one of their priorities in their overall efforts to foster sustainable growth. It is important for a safe biotechnology strategy to become a part of this policy goal. The first step in formulating such a policy is to address the role that safe biotechnology can play in promoting economic and social progress. The issue extends well beyond simplistic arguments for feeding the world. Instead, it is about considering safe biotechnology as a set of techniques that can be used for: (1) increasing crop productivity and adaptability; (2) diversifying crops; (3) enhancing nutritional value of food; (4) reducing environmental impacts of agricultural production; and (5) promoting market competitiveness.

The second step in this strategy includes identification of crops that can benefit from a safe biotechnology programme. To its detri-

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ment, modern African agriculture has neglected traditional crops, opting instead to invest in commercial crops, many of which are exotic to its environment.

Recent surveys show that African research institutes have begun to concentrate on such indigenous crops as cassava, maize, banana, yam, cowpea and sorghum. These studies also show that researchers at these institutes rarely turn to advanced techniques of molecular biology and genetic engineering. That shortcoming blunts the potential impact of their work, especially in addressing such critical issues as disease control, weed management and plant adaptation to drought conditions.

NICHE MARKETS

Effective use of safe biotechnology may not only help African countries boost their food supplies but could prove useful in the creation of niche markets resulting from the commercialization of traditional crops.

Such niche markets could be important for several reasons.

First, they could enable less developed countries to enter the technology market without having to compete at the frontier of the technology's development. Put another way, niche markets allow countries to acquire the requisite technological knowledge without being subject to the demands of market competition. This might be particularly true in applications of safe biotechnology for both agricultural production and medicinal R&D.

Second, niche markets could emerge as lucrative sources of economic activity. Carving out technology niches, through the utilization of biotechnology, may be an important way of applying new techniques to local problems for which there is little interest among international corporations.

Third, countries that are explicit about their interest in operating in market niches are more likely to benefit from technological cooperation with firms in industrialized countries. Although market niches created by developing countries are not likely to threaten the financial well-being of major firms in the North, such niches nevertheless provide market information that is relevant to larger corporations eager to expand their markets into untapped areas.

Fourth, successful development of market niches may itself be a significant step on the path toward technological development. For example, developing nations that have built their capacity in certain sectors of tissue culture technology have greater potential to move into genetic manipulation than developing countries that have to start from scratch.

Finally, the pursuit of market niches could help developing countries identify and test both the opportunities and obstacles

they face in seeking technological development. In other words, such efforts could help shed light on a nation's institutional strengths and weaknesses when it comes to innovation initiatives. The knowledge and experience acquired as a result of efforts to develop market niches could prove invaluable in the design of other technology development programmes.

PRIVATE INVESTMENT

Beyond its potential value to food production and the development of niche markets, the pursuit of safe biotechnology may help expand the role of the private sector—domestic and foreign—in scientific research and technological development in Africa.

An important feature of today's global science order is the growing role of the private sector in scientific research. An increasing number of industrialized countries have created incentives and institutional arrangements that promote the transfer of research activities and findings from the public to private sector. In such a climate, reliance on public institutions as the main vehicles for technological development—which remains the prevailing strategy in Africa and throughout much of the developing world—offers little prospect for success.

In many African countries, government, academia and industry maintain relations of mutual antagonism and suspicion—despite the fact that a country's ability to compete today depends largely on the degree to which these three segments of society work together to exploit a nation's areas of competitive advantage.

A policy focus on safe agricultural biotechnology and biomedical research involving a wide range of actors requires a strategy that fosters public-/private-sector cooperation. Indeed developing countries in Asia have often targeted select fields—for example, in microelectronics—as a way of building the critical mass of expertise and manufacturing capabilities they need to compete successfully in the global market place.

Such strategies often result in the creation of "technological communities" drawn together by an intricate network of competition and cooperation that promotes an environment of innovation. A community of key actors in industry, academia and government, for example, collectively push for technological advances through roundtable discussions and other information exchange fora.

A major limitation of technology policy in Africa and much of the developed world has been the failure to recognize private enterprise as a central player in the accumulation and application of technology. Private firms are not simply commercial entities but important nodes in the global innovation system. Firms are also the institutional locus in which technological learning takes place. They not only emerge from the accumulation of technological capabilities but influence the rate and direction of these capabilities. In other words, firms are both the recipients and instigators of technological progress.

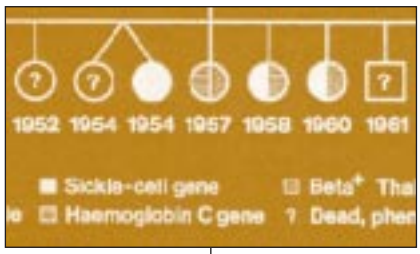
And that may prove to be still another reason for African nations to pursue the development of safe biotechnology: A comprehensive safe biotechnology strategy, linking scientific research to economic development to global markets, may help to create a larger role for the private sector in the creation and transfer of science and technology.

The success of other continents and regions in harnessing the benefits of science and technology are due in part to the presence of a strong private sector actively involved in the R&D process. Without such a presence, Africa's efforts to promote the rapid accumulation of scientific and technological capabilities are likely to stall or be redirected in ways that fail to fully address the needs of its citizens. ■

Calestous Juma
Special Advisor
Center for International Development
Harvard University
USA

MANAGING THE PATIENT

Africa's often overlooked contributions to global medicine are based on principles that put patients before publications.



SICKLE CELLS WERE FIRST DISCOVERED BY U.S. PHYSICIAN, JAMES HERRICK, IN 1910. LOOKING THROUGH THE MICROSCOPE AT THE RED BLOOD CELLS OF A BLACK STUDENT WITH ANAEMIA AND FREQUENT JOINT PAINS, HERRICK, TO HIS SURPRISE, OBSERVED WHAT HE CALLED "PECULIAR SICKLE SHAPED CELLS" INSTEAD OF EXPECTED ROUND CELLS.

WHAT IS A SICKLE CELL TRAIT?

Brothers, sisters and parents of patients with sickle cell anaemia may be completely free of anaemia, and sickle cells may not appear in their blood film when examined under a microscope. Nevertheless, round red cells of healthy parents and some siblings of anaemic patients become sickle shape when their blood is placed on a slide and deprived of oxygen.

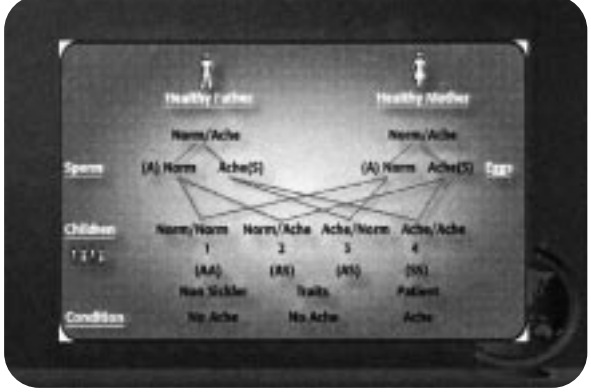
In other words, take the blood of the healthy parents of a sickle cell anaemia person. Examine the cells under the microscope and you will find no crescent shaped cells. But deprive the blood of oxygen and within minutes, these cells alter their shape from round to sickle. Such healthy parents, whose sickling contribution to their offspring can only be discovered by the sickling test, are known to possess the AS or "norm/ache" sickle cell trait (A for the normal haemoglobin, and S for the ache-producing haemoglobin).

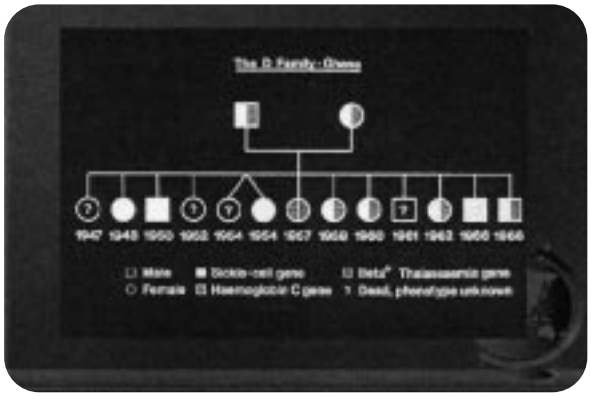
While one can examine a sickle cell anaemia person and discover the jaundiced eyes and sometimes other features like leg ulcers, there's no way of discovering a sickle cell trait person without doing the sickling test.

Who is vulnerable to this problem? Black people (the first to be described with sickle cells and anaemia), white people from the Mediterranean, and non-blacks in the Middle East and India. Aching occurs only when one inherits two ache or SS haemoglobins.

WHAT'S THE CAUSE?

Through what is known as haemoglobin electrophoresis, Linus Pauling's team in 1949 discovered that the blood protein 'haemoglobin' in sickle cell anaemia persons differed from normal haemoglobin, and that the electrophoretic mobility of the two haemoglobins (A and S) were significantly different over a wide range of pH. The healthy sickle cell trait had two haemoglobins (A and S, one from father and the other from mother). Meanwhile, an anaemic





offspring with a sickling contribution from both parents had only one haemoglobin (designated SS in genetics for one S from each parent). Pauling received the Nobel Prize for the discovery.

Unlike normal haemoglobin A, which keeps the cell membrane round even without oxygen, haemoglobin S gels up into a sickle shape when de-oxygenated. The defect causing sickle haemoglobin to stiffen in the absence of oxygen was traced to beta-globin polypeptide where at position β^6 valine replaces glutamic acid of normal haemoglobin. Other 'point mutations' in the β-chain were soon discovered to unmask a vast number of 'abnormal' haemoglobins, including haemoglobins C and Korle Bu.

PATIENT VS. DISEASE

Medical practitioners in the developed world often miss the difference between the 'sickle cell disease' and the 'sickle cell disease patient.' Examining a patient's blood under a microscope is not the same as examining the patient. Consideration, for example, should be given to the genetic environment of a person with sickle cell anaemia. Phenotype SS also could have 1α or 2α-thalassaemia, plus G6PD deficiency—common genes that modify the severity of the disease. In fact, one in four African males has G6PD deficiency inherited from the mother's X-chromosome. As a result, it's essential to find out the G6PD status of every patient with sickle cell anaemia. This is rarely done by medical practitioners in developed countries.

Non-genetic factors matter as well. Some African sickle cell anaemia patients accurately forecast heavy rainfall because changes in atmospheric pressure spur severe joint pains. Others, meanwhile, are adversely affected by cold weather. In fact, external circumstances could be more important than haemoglobin levels in prompting symptoms among sickle cell anaemia patients.

Medical management differs depending on whether one is managing a disease or managing a person. *Prescribers' Journal* is the 'doctor's guide' for medical treatment in the United Kingdom. What is published there is taken as the 'rule of law' among medical practitioners. In an article published in the *Prescribers' Journal* in the early 1990s, Britain's leading sickle cell research and medical centre advocated the use of morphine to relieve pain among sickle cell patients, even for children. Today some teaching hospitals in London prescribe heroin (diamorphine) as a pain killer for sickle cell patients.

The U.S. *Code of Federal Regulation* bans the use of heroin in medicine because the drug carries a "high potential for abuse." Yet, diamorphine (heroin) is approved for use in the UK for sickle cell anaemia patients. As Graham Serjeant, who has vast experience treating sickle cell anaemia patients in the West Indies, states: "In Jamaican experience, morphine or its derivatives are rarely used or necessary." Serjeant raises a key question: Why should a Ghanaian or West Indian who has never been subject to opiates in his or her own country be put on a morphine or diamorphine pump for treatment of his or her first crisis in the UK? Haematologists who have never answered this question have a great deal to learn from their colleagues in the West Indies and West Africa.

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Service, education, research, in that order, is what resource-strapped medical practitioners in the Third World emphasize in their patient-oriented programmes. Meanwhile, medical practitioners in the developed world, awash with resources, reverse that order, making research a top priority and service a desirable but by no means essential pursuit.

Medical practitioners from the developing world refuse to define the sickle cell trait as a disease, while in the developed world its detection has often led to commercial exploitation. Athletes with sickle cell traits have competed in the Olympic Games and beaten the world's best runners even in the high altitude of Mexico City. There's nothing wrong with them. Indeed, in places where malaria is prevalent, individuals with sickle cell traits often display more resilience against the disease than those without the trait.

GENETIC COUNSELLING

Medical practitioners in the developed world widely recommend pre-natal diagnosis of sickle cell traits and often urge an abortion if tests reveal sickle cell disease in the foetus. Meanwhile, experts in African medicine have pointed out that apart from the two S genes, more than 9,998 other genes are in a foetus, some perhaps genes of genius. Would eliminating the foetus not be eliminating genius? Family studies in Africa and the West Indies are replete with examples of the person who has sickle cell disease also being the person with the best brains.

Moreover, many African families recoil at the suggestion that the pregnancy be terminated at the finding of no normal haemoglobin gene. Families with an affected child often consider it a personal matter and arrive at their own conclusions without embracing the 'received wisdom' of a Western genetic counsellor to abort what the latter considers an 'imperfect foetus.'

Education and genetic counselling in the African setting should be used to explain how sickle cell disease occurs. Even illiterates understand how non-ache parents (norm/ache phenotype) can produce aching children (ache/ache phenotype). They have a right to be told what the chances are of giving birth to a sickle cell disease child and then be given the freedom to decide for themselves highly personal issues relating to marriage partners and procreation. In 1969, fellow researcher Bela Ringelhann and I met a family where both the father and mother were ache/ache; all 13 children were ache/ache as well. A doctor today specializing merely in disease, not people, may have been tempted to abort all the children in the name of eliminating the sickle cell gene. The reality is that four of this family's children died, but the rest are now young adults living normal, productive lives.

Unlike their counterparts in developed countries, African medical experts do not have the audacity to decide which people with a hereditary disease should live and which should not. Instead, our role has been to educate patients about the risks and then leave decisions up to them. I believe that medical experts in the developed world provide an invaluable service to their patients by pursuing a similar strategy and becoming more vocal in opposing pre-natal diagnosis and selective abortion.

Service, education, research, in that order, is what resource-strapped medical practitioners in the Third World emphasize...

As an observer of my own siblings and relatives who suffered the pain of sickle cell disease, and as a doctor who has looked after a few thousand sickle cell patients, I am convinced that the most vital discipline in support of the sickle cell disease patient is not clinical medicine (my own discipline); nor is it genetics, haematology, or biochemistry. While medical practitioners in the developed world are banking on bone marrow transplantation and standard DNA for answers, the strategy that has achieved results in the developing world is based on its own special brand of DNA—Doctoring, Nursing and Antibiotics. This "dna" strategy may not be exotic but it has been effective—and that, after all, is the ultimate goal of medicine. ■

Felix I.D. Konotey-Ahulu
Former Director, Ghana Institute of Clinical Genetics, Korle Bu, Teaching Hospital, Accra, Ghana
Consultant Physician, Cromwell Hospital, London, United Kingdom

NEW TECHNOLOGIES FOR DEVELOPMENT IN THE SOUTH

THIRTEEN HIGH-LEVEL OFFICIALS, INCLUDING EIGHT GOVERNMENTAL MINISTERS OF SCIENCE, TECHNOLOGY, RESEARCH AND HIGHER EDUCATION, MET ON TUESDAY AFTERNOON, 23 NOVEMBER, DURING THE SENEGAL CONFERENCE TO ENGAGE IN A WIDE-RANGING DISCUSSION ON THE "RISKS AND OPPORTUNITIES" FOR DEVELOPMENT POSED BY NEW TECHNOLOGIES FOR THIRD WORLD COUNTRIES.

The session opened with a message from **His Royal Highness Prince El Hassan bin Talal of the Hashemite Kingdom of Jordan**. Throughout history, the Prince noted, all new technologies have entailed risks and opportunities—and today's emerging technologies are no exception. "Ultimately," he declared, "there is no such thing as user-friendly or user-unfriendly technology; the friendliness and unfriendliness both come from humans." The Prince pointed out that "development is not just industrialization, nor is it infrastructure, or a nation's gross national product (GNP). It is also culture and, above all, humanitarianism." To address these concerns, he called for "a more universal and humanitarian moral code."

THE NEED TO INTEGRATE NEW TECHNOLOGIES INTO THE PREVAILING CULTURES OF THE DEVELOPING WORLD WAS A MAJOR THEME OF THE PANEL. HERE'S A SNAP-SHOT SUMMARY OF WHAT EACH OF THE PARTICIPANTS HAD TO SAY.

Philippe Lazar
President, Institute of Research for Development (IRD), Paris, France

noted that the new global technologies "come at a price," which all nations—developed and developing—must calculate. He observed that such assessments have accounted for the public's scepticism towards nuclear power in the recent past and genetic engineering more recently. Lazar added that policy makers must engage the public in discussions on both the benefits and liabilities associated with advances in science and technology. Scientific research takes place in the laboratory, he concluded, but the pursuit of science and technology cannot be sustained without the involvement of the entire society. ■

Abdel Salam A. Majali
President, Islamic Academy of Sciences, Jordan

asserted that developing countries must strengthen their overall educational systems in general and higher educational systems in particular "to instil a culture of research" among their people. Majali also stated that developing countries should improve the quality of their research institutions and encourage their

business and industrial sectors to become more involved in research and development as part of a larger effort to nurture a culture of research within their borders. ■

Muhammad N.U. Khan
Minister for Science and Technology, Bangladesh

emphasized the opportunities that biotechnology presents for the development of miracle drugs and hardier crops. He also maintained that biotechnology involves knowledge and techniques that are more easily accessible than other emerging technologies, potentially leading to rapid improvements in public health and food production. But the picture of a world in which biotechnology plays a central role includes dark as well as bright hues of colour. Beyond the ecological risks posed by biotechnology (genetically uniform plants could prove more vulnerable to pests and diseases over the long run), Khan contended that there are critical cultural questions as well: Biotechnology could make farmers in the developing world dependent on international corporations for their annual seed stock. It could also make them beholden to outside sources for vital information on farming techniques—thus uprooting centuries-old farming practices and the traditional ways of life that have accompanied such labour. ■

José I. Vargas
President of TWAS and TWNSO, and former Minister of Science and Technology, Brazil

declared that just as unprecedented advances in information technology—particularly the rapid expansion of the world-wide internet—had turned English into a global language, new software may now reverse that trend through simultaneous computerized translations of many languages. Today's state-of-the-art software can simultaneously translate 15 languages; researchers are confident that 75 simultaneous translations will soon be a reality. Not only will individual researchers be able to work in their native language but English's global stranglehold on the culture of science may be loosened as well. ■

Francis V. Wodie
Minister of Higher Education and Scientific Research, Côte d'Ivoire

stated that science and technology represent the common heritage of humankind but the benefits of these two forces—which have largely defined our global society in the 20th century—are not distributed equally across the globe. The major reasons for gaping North/South discrepancies in the development and application of science and technology are a lack of political will and a lack of funding in developing countries. Wodie observed that the Lagos Plan of Action for the Economic Development of Africa 1980-2000 called on each African nation to invest 1 percent of its annual gross domestic product (GDP) in science and technology by 2000. The reality, however, is that African nations on average spent only between 0.2 percent and 0.5 percent of their annual GDP on science and technology in 1999. ■

Mostafa N. Moin,
Minister for Culture and Higher Education, Islamic Republic of Iran

expressed his dissatisfaction with the way that industrialized countries have dismissed countries in the South as "developing countries." Indeed Moin observed that the genesis of science can be found in these so-called developing countries, many of which enjoy a rich heritage in science. Moin urged the nations of the South to re-examine their scientific past as a source of inspiration for gaining a greater share of the benefits of science and technology in the future. He noted that globally a forceful trend has emerged seeking to place science squarely within each nation's and region's cultural traditions. Nations in the South should take advantage of this trend in devising their own strategies for advancing science and technology during the next century. In words reminiscent of TWAS founder Abdus Salam, Moin noted that science and technology are not reserved for a few nations, but are the common heritage of all humankind.

Danny C. Pule,
Deputy Minister for Science, Technology and Vocational Training, Zambia

declared that the acquisition of scientific and technological knowledge confers economic power. He also observed that while rapid advances in material science and biotechnology create opportunities for countries like Zambia, such state-of-the-art technologies pose challenges too. For example, the on-going development of silicon-based fibre optics has seriously dampened global demand for Zambian copper, thus reducing the earning potential of one of the country's most important exports. Meanwhile, genetic engineering threatens to place Zambia's traditional export crops, including cotton, sugar, ground nuts and maize, at economic risk. Pule also maintained that the new global technologies would likely increase levels of economic and social inequality as capital-intensive investment replaces labour-intensive investment as the driving force behind development. These risks, however, are counterbalanced by the opportunities that new technologies create, particularly in fields related to communications, remote sensing and agro-based industries, which promise to improve the prospects for education, natural resource management and food production, respectively. Taking full advantage of these opportunities will require strong commitments from governments in the developing world to invest in science and technology.

Chief Ebitimi Baningo,
Federal Minister for Science and Technology, Nigeria

listed two critical factors for improving the state of science and technology: (1) nurturing popular support for the development of science and technology and (2) promoting greater private-sector involvement in efforts to advance science-based development. Baningo also highlighted the importance of South-South cooperation and the need for nations in the South to refocus their research efforts on such emerging fields of scientific inquiry as information technologies and biotechnology. He concluded by saying that recent political developments in Nigeria have set the stage for dramatic advances in science and technology policies and

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programmes, but it was difficult to assess either the full nature of these changes or their potential impacts at this early stage in the reform process. ■

Farouk Brimah
Deputy Minister of Environment, Science and Technology, Ghana

pointed to the "Vision 2000" report recently issued by the government of Ghana, which emphasizes the need to develop biotechnology, material science and information technologies as critical elements in the nation's blueprint for economic development. In biotechnology, he noted, Ghana would concentrate on applications related to cocoa and medicinal plants, both of which are in plentiful supply in Ghana. In information technologies, Ghana would pursue the development of electronic mail networks for use by agricultural institutions and seek to launch low-cost networks suitable for university distant learning. In material science, Ghana would establish a material science centre within the framework created by the Commission on Science and Technology for Sustainable Development in the South (COMSATS). Despite the progress that is likely to take place, Brimah acknowledged that his nation's efforts will continue to be handicapped by an inadequate technological infrastructure and an insufficient number of skilled personnel. ■

Mohamed Y.M. Moursy
President of the Academy of Scientific Research and Technology, Egypt

contended that advances in the following fields of science and technology are likely to have significant impacts on economic and social development in developing countries: microelectronics and computers, biotechnology and genetic engineering, new materials, fibre optics, laser technologies, informatics, and marine and space technologies. Because each of these technologies is capital-, not labour-, intensive, countries throughout the South must improve the skill levels of their workforce and the capabilities of their computer and internet infrastructures if they are to compete successfully in the next century. Developing nations, he observed, must foster an environment for knowledge generation and innovation. Such initiatives require stronger ties among government, industries and universities, and closer collaborations between public and private stakeholders. ■

Younous H. Dicko
Minister for Secondary Education, Higher Education and Research, Mali

commented that only 50 percent of Mali's school-age children attend school, compared to more than 90 percent of school-age children in most developed countries. Such a small percentage of school attendance will seriously handicap Mali's efforts for science- and technology-based development in the next century. In fact, unless improvements in primary and secondary schooling take place, Dicko concluded that Mali will

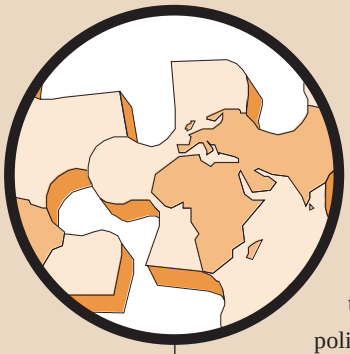
be hard pressed to reach its economic development goals regardless of the nation's investments in other areas of science and technology. As a critical aspect of a broader strategy, he called for measures to instil a greater sense of awareness among the population for the positive impacts that science and technology could have on current and future generations. ■

Omay Fassi-Fehri
Secretary of State for Scientific Research, Morocco

offered a detailed overview of the links among science, technology, environment and economic development, particularly in relation to long-term efforts to reduce poverty levels in developing countries. Fassi-Fehri acknowledged that science and technology were not unalloyed elements for success; indeed these forces, he noted, could produce adverse as well as positive impacts. But science and technology's potential benefits made the risks worth taking and he urged governments in the South and non-governmental agencies both in the South and North that foster international co-operation to lead the charge for bringing the full benefits of science and technology to the developing world. ■

Balla Moussa Daffe
Minister for Scientific Research and Technology, Senegal

summarized the comments offered by those participating in the panel discussion. He noted that the participants shared many common observations. Among them were: (1) science and technology, especially advances in the fields of information technology, biotechnology and material science, would be the keys to development in the 21st century; (2) information technologies, in particular, broadened opportunities for the exchange of data, which could accelerate science-based development throughout the South; (3) scientific and technological progress must take place within the contours of existing cultural values if such efforts are to gain the support and confidence of the people; (4) developing nations should pursue activities that increase public awareness and appreciation for the benefits of science and technology; (5) sustained progress in science-base development requires sustained political commitment; and (6) investments in human resources—namely, education and training—may prove to be the most valuable expenditures a nation makes in its efforts to tap the benefits of science and technology. The consensus reached during the panel discussion, Daffe concluded, will not minimize the challenges that lie ahead. Identifying the problems, however difficult, pales in significance to finding effective solutions. Those solutions, he noted, would likely emerge from the common ground of concerns outlined in Senegal. Now that we had reached agreement on the nature of the problems, Daffe asserted that it was time to devise a blueprint for action to address these problems. He was confident that the Dakar Declaration, which would be presented at the conclusion of the conference, would mark an important step in this effort. ■



TWNSO RECEIVES THREE NEW GRANTS

Projects will examine successful examples of scientific research and technological development in the South.

The Third World Network of Scientific Organizations (TWNSO) has recently been awarded three separate grants—from the United Nations Environment Programme (UNEP) Global Environment Facility (GEF), the United Nations Development Programme (UNDP) Special Unit for Technical Cooperation among Developing Countries (TCDC) and the World Meteorological Organization (WMO). TWNSO, whose membership consists of 155 scientific organizations (including 34 ministries of science and technology and 90 scientific academies and research councils) from the developing world, is an affiliate organization of the Third World Academy of Sciences (TWAS). TWAS will collaborate with TWNSO on each of the projects.

The grants deal with a wide range of topics—from the use of medicinal and indigenous plants, to the protection of biodiversity in arid and semi-arid lands, to improved water management practices in the developing world.

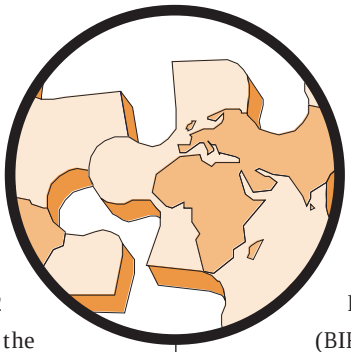
Despite their diverse areas of study, the projects are united by this one goal: to showcase science-based initiatives throughout the South that have significantly improved the quality of life for everyday people. In short, the projects hope to highlight some of the "best practices" in sustainable resource use and long-term economic development currently taking place in the developing world.

"There's no doubt that developing countries are burdened by a host of serious problems," says Mohamed H.A. Hassan, Executive Director of TWAS. "But the news media—particularly in the North—often focus on the South's economic, social and political troubles while failing to provide sufficient information about some of the good work that is being done to improve the circumstances of common people. That is one of the goals of these projects: to put the spotlight on activities that have made a difference."

"Our efforts," adds José I. Vargas, President of both TWAS and TWNSO, "are designed not only to alter perceptions of what is going on in the developing world but to provide a vehicle that allows nations, regions and communities throughout the South to learn from one another. The wealth of material we hope to produce could serve as helpful guides on how to address issues of critical importance to people throughout the developing world, providing valuable information to public officials, grassroots organizations and international donor agencies."

The three projects will seek to build on the experience that TWNSO and TWAS acquired in putting together the monograph, *Sharing Innovative Experiences*, an 18-month project sponsored by the UNDP Special Unit for TCDC completed in 1999. The cornerstone of this effort was a 230-page book that examines successful science-based initiatives for sustainable development in 15 countries throughout the South in such critical areas as food security, public health and electronic communications.

"We have distributed 5000 copies of the monograph to institutes and individuals around the globe," notes Atsede Worede, who directed the project for the UNDP Special Unit for TCDC. "Our mailing list includes not just university and research libraries but the offices of government officials, technical support groups and community activists who have been encouraged to use the information to advance their own development efforts."



The largest of TWNSO's three new grant-funded initiatives is a project funded by UNEP Global Environment Facility. The effort, which began this fall and will take 2 years to complete, will examine the breadth of biodiversity in arid and semi-arid regions and seek to devise strategies for protecting these valuable resources without undermining their potential commercial value.

"Again, the overall goal of the project is to provide a way for institutions throughout the South to share useful information about their experiences," says Hassan. "The key word in this effort is 'useful.' That is why, in addition to a monograph, we plan to host four workshops and an international conference where participants from around the world will be able to exchange knowledge and ideas about their related experiences."

"This will not be an academic exercise," declares Vargas, "but a hands-on experience in the transfer of knowledge that we anticipate will have an impact far beyond the activities associated with the project itself. Among the institutions participating in this initiative are the Desert Research Centre in Egypt, the Regional Centre for the Study of Arid and Semi-Arid Regions in Mexico, the Mongolian Academy of Sciences Institute of Biological Sciences and the Senegalese Institute of Agricultural Research. In all, 22 institutions in the developing world will each profile two of their most successful projects."

At the same time, TWNSO has received funds from the UNDP Special Unit for TCDC to prepare another volume of successful case studies on the use of science and technology in the developing world. "The new volume," notes UNDP's Worede, "will focus on successful experiences in the developing world on the use of indigenous and medicinal plants. We hope to catalogue how these valuable resources have been used to advance our shared goal for sustainable development." Among the 22 institutes that have been asked to participate are the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM), the Chinese Academy of Medical Sciences Institute of Medicinal Plants, the International Potato Centre in Peru, and the Swaziland Centre for Research in Medicinal and Indigenous Food Plants.

TWNSO also has received a grant from the World Meteorological Organization (WMO), headquartered in Geneva, Switzerland, to prepare a series of case studies on effective water management practices throughout the developing world. "The goal of the project," observes WMO's secretary general, G.O.P. Obasi, "is to provide information on hydrological issues that will likely move to the forefront of global concerns, particularly in the developing world, by early next century. In fact, in the Middle East and portions of sub-Saharan Africa, water management is currently one of the most critical issues faced by communities and regions. We hope this project offers valuable lessons from which others can learn."

"And that's the point of all three projects," says Vargas. "We hope that each provides a forum for sharing information to improve resource use throughout the developing world. At the same time, we hope that each provides signposts leading to a future marked by sustainable economic growth and better living conditions for people throughout the South."

For additional information about each of these projects, please contact **Helen Martin, TWNSO Secretariat**, c/o ICTP, Strada Costiera 11, 34014 Trieste, Italy; phone: + 39 040 2240 386; fax: 39 040 224559; e-mail: twnso@ictp.trieste.it; web: http://www.ictp.trieste.it/~twas/TWNSO.html.

Koichiro Matsuura

UNESCO'S NEW DIRECTOR

Koichiro Matsuura is the new Director-General of the United Nations Educational, Scientific and Cultural Organization (UNESCO). He was appointed to the post during the organization's General Conference on 12 November 1999. Just before assuming the reigns of UNESCO, Matsuura served as Japan's Ambassador to France, Djibouti and Andorra, and as Chairperson of UNESCO's World Heritage Committee. Earlier in his career, he was Japan's Deputy Minister for Foreign Affairs and Director-General of the Economic Cooperation Bureau, where he directed Japan's overseas development assistance efforts. Matsuura's distinguished career in international diplomacy has included posts in Africa, the United States and Europe. He speaks Japanese, English, French and Spanish. Matsuura will succeed Federico Mayor (TWAS Associate Fellow 1991), who headed UNESCO since 1987.

ZEWAIL WINS NOBEL

Ahmed H. Zewail (TWAS Fellow 1989) is the recipient of the 1999 Nobel Prize in Chemistry. He received the prize for developing a laser technique—"femtosecond spectroscopy"—that reveals in real time how the bonds between chemical molecules break down and then reform even during the most rapid reactions. The laser technique involves two pulses of high-speed lasers—one to excite the molecules; the other to reveal the molecules' behaviour. In its official announcement of Zewail's Nobel award, the Royal Swedish Academy of Sciences stated that his discovery, which took place in the 1980s, "brought about a revolution in chemistry," shedding new and revealing light on our understanding of catalysts, polymers and miniature electronic components. At the same time, applications of Zewail's discovery have helped broaden our knowledge of such biological processes as photosynthesis and animal vision. Zewail, who was born in Egypt, received his undergraduate and masters' degree from Alexandria University in Egypt and his doctorate from the University of Pennsylvania in the United States. He is currently the Linus Pauling Professor of Physics at California Institute of Technology. He also serves as the Director of the U.S. National Science Foundation Laboratory for Molecular Sciences. Sixteen TWAS members have now won the Nobel Prize, including TWAS's founding President, the late Abdus Salam.

Ahmed H. Zewail

NORTH/SOUTH TIES

Anton Vratuša, Honorary President of the International Center for Promotion of Enterprises (ICPE) in Ljubljana, Slovenia, recently visited the headquarters of TWAS to discuss prospects for pursuing co-operative projects in science and technology between ICPE and the Academy. The projects would focus on issues of mutual concern to the North and South. Vratuša, who was Deputy Prime Minister of Yugoslavia in the late 1970s and Prime Minster of the Republic of Slovenia in the early 1980s, believes Slovenia's unique geopolitical position offers his country an opportunity to re-launch activities related to North-South and East-West co-operation. "When the former Yugoslavia broke up earlier this decade," Vratuša explains, "political leaders in the newly independent Slovenia concentrated their efforts, above all, on strengthening Slovenia's position as an independent European state and joining the European Union. Now that this important task is well on its way to being fulfilled, it may be time to return to some previous activities, including serving as a bridge between the North and South. That's where the ICPE may again serve a vital role." Over the past decade, membership in the Center, which consists largely of developing na-

tions, has dwindled from 30 to 12. Vratuša hopes Slovenia's normalized relations with Western Europe will allow his nation to pay more attention to its links with developing nations in the South and countries with economies in transition in eastern and central Europe. Efforts to increase scientific, technological and economic exchanges among these diverse regions, he believes, would benefit all parties and have a positive impact on initiatives to reduce global tensions. Such efforts, moreover, are where TWAS and Center may find common ground. For additional information about ICPE, please contact the International Center for Promotion of Enterprises, Dunajska 104, 1109 Ljubljana, PO Box 2592, Slovenia, fax: (386 61) 346 389.

C.R. RAO HONOURED

"Statistics: Reflections on the Past and Visions for the Future," an international conference at the University of Texas at San Antonio (USA) scheduled to take place from 16-20 March 2000, will be held in honour of **C. Radhakrishna Rao** on the occasion of his 80th birthday. Rao, a Founding Fellow of the Third World Academy of Sciences (TWAS), is one of the world's foremost creative thinkers in the field of statistics. Educated in India and the United Kingdom, he ranks among only a handful of scientists who have influenced the direction of statistical research in the 20th century. Rao holds the Eberly Family Chair in Statistics and directs the Center for Multivariate Analysis at Pennsylvania State University in University Park, Pennsylvania, USA. He is a fellow

C.R. Rao

of the Royal Society (U.K.) and Indian National Science Academy, Indian Academy of Sciences and National Academy of Sciences, India; a member of the U.S. National Academy; foreign member of the Lithuanian Academy of Sciences; and honorary fellow of the American Academy of Arts and Sciences. Over the course of his illustrious career, he has received 21 honorary degrees from 14 nations. His major fields of research include linear algebra, theory of estimation and multivariate analysis.

UNESCO CHAIR

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has established the first UNESCO Chair of Biophysics and Molecular Neurobiology at the Institute of Biochemical Research (*Instituto de Investigaciones Bioquímicas de Bahía Blanca* [INIBIBB]) in Bahía Blanca, Argentina. INIBIBB is one of the centres participating in the TWAS Associateship Scheme. UNESCO "chairs" seek to maximize the regional pool of expertise in designated fields through inter-regional exchanges. The goal is to foster greater communication among scientists while facilitating graduate student training. *Centro de Estudios Científicos de Santiago* in Chile and *Laboratório de Bioenergetica* of the *Universidade Federal de Rio de Janeiro* in Brazil provided key support in the selection of INIBIBB. The "chair's" first activity, which was supervised by INIBIBB's head **Francisco J. Barrantes**, took place last spring. The course, designed for advanced doctoral students and featuring the participation of several specialists from abroad, focused on membrane biophysics. Those successfully completing the course received 60 credit hours. For additional information on the activities of the UNESCO Chair of Biophysics and Molecular Neurobiology, fax (054) 291 4861200 or e-mail rtfjb1@criba.edu.ar. For more general information about the Institute of Biochemical Research, see *Profiles of Institutions for Scientific Exchange and Training in the South* (Trieste: Third World Network of Scientific Organizations [TWNSO], 1999) or http://www.ictp.trieste.it/~twas/Profil.html#Arg-INIBIBB.

Francisco J. Barrantes

WHAT'S TWAS?

THE THIRD WORLD ACADEMY OF SCIENCES (TWAS) WAS FOUNDED IN 1983 BY A GROUP OF EMINENT SCIENTISTS FROM THE SOUTH UNDER THE LEADERSHIP OF THE LATE NOBEL LAUREATE ABDUS SALAM OF PAKISTAN. LAUNCHED OFFICIALLY IN TRIESTE, ITALY, IN 1985 BY THE FORMER SECRETARY GENERAL OF THE UNITED NATIONS, TWAS WAS GRANTED OFFICIAL NON-GOVERNMENTAL STATUS BY THE UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL THE SAME YEAR.

At present, TWAS has 512 members from 76 countries, 62 of which are developing countries. A Council of 14 members is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a small secretariat of 10 persons, headed by the Executive Director. The secretariat is located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy, which is administered by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Atomic Energy Agency (IAEA). UNESCO is also responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Ministry of Foreign Affairs of Italy.

The main objectives of TWAS are to:

- Recognize, support and promote excellence in scientific research in the South.
- Provide promising scientists in the South with research facilities necessary for the advancement of their work.
- Facilitate contacts between individual scientists and institutions in the South.
- Encourage South-North cooperation between individuals and centres of scholarship.

TWAS was instrumental in the establishment in 1988 of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of 154 scientific organizations from Third World countries, whose goal is to assist in building political and scientific leadership for science-based economic development in the South and to promote sustainable development through broad-based partnerships in science and technology.

TWAS also played a key role in the establishment of the Third World Organization for Women in Science (TWOWS), which was officially launched in Cairo in 1993. TWOWS has a membership of more than 1900 women scientists from 83 Third World countries. Its main objectives are to promote the research efforts and training opportunities of women scientists in the Third World and to strengthen their role in the decision-making and development processes. The secretariat of TWOWS is currently hosted and assisted by TWAS.

WANT TO KNOW MORE?

TWAS offers scientists in the Third World a variety of grants and fellowships. To find out more about these opportunities, check out the TWAS web-pages! Our main page is at:
http://www.ictp.trieste.it/~twas

FELLOWSHIPS

Want to spend some time at a research institution in another developing country? Investigate the South-South Fellowships:
http://www.ictp.trieste.it/~twas/SS-fellowships_form.html

GRANTS

Need funding for your research project? Take a look at the TWAS Research Grants:
http://www.ictp.trieste.it/~twas/RG_form.html
TWNSO runs a similar scheme, for projects carried out in collaboration with institutions in other countries in the South:
http://www.ictp.trieste.it/~twas/TWNSO_RG_form.html

EQUIPMENT

But that's not all TWAS has to offer. For instance, do you need a minor spare part for some of your laboratory equipment, no big deal, really, but you just can't get it anywhere locally? Well, TWAS can help:
http://www.ictp.trieste.it/~twas/SP_form.html

TRAVEL

Would you like to invite an eminent scholar to your institution, but need funding for his/her travel? Examine these pages, then:
http://www.ictp.trieste.it/~twas/Lect_form.html
http://www.ictp.trieste.it/~twas/Prof.html

CONFERENCES

You're organizing a scientific conference and would like to involve young scientists from the region? You may find what you are looking for here:
http://www.ictp.trieste.it/~twas/SM_form.html