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ALL THOSE WHO HAVE HAD AN OPPORTUNITY TO VISIT ALEXANDRIA HAVE HAD THE GOOD FORTUNE TO STAND BOTH IN THE SHADOW OF HISTORY AND IN THE GLARE OF CURRENT EVENTS AND TO CONSIDER, FIRSTHAND, THE ROLE THAT THE MIDDLE EAST AND THE ENTIRE MEDITERRANEAN HAVE PLAYED – AND WILL CONTINUE TO PLAY – IN CREATING ENLIGHTENED SOCIETIES.

Alexandria's Past: Prologue to Success

For sociologists, it is a pilgrimage to one of the world's oldest and greatest societies, a rare opportunity to explore the 'Florence' of the ancient world; for political scientists, it is a chance to examine one of antiquity's primary centres of commerce and conflict, where Egyptian, Greek and Asian societies intermingled, both in war and peace; and for scientists, it is an unprecedented occasion to explore the deepest roots of their profession, a place where many of the fundamental principles of science and mathematics were first articulated.

Much of the intellectual ferment that took place in this ancient city, founded by and named after Alexander the Great, occurred in the ancient Library of Alexandria. It was there that the circumference of the earth was first measured; the heavenly constellations first mapped; and the fundamental principles of the scientific method – hypothesis, verification and replication – first put into practice. Over its 600 year history, from 300 BCE (before the common era, or BC) to 300 CE (AD), the library remained an unrivalled institution in its quest for knowledge.

Yet the library was more than a place for intellectual discourse and scientific exploration. In its fullest expression, it represented an incomparable marriage of art, music, scholarship and science. As both an ideal and a structure, it symbolized and signified the unity of all forms of knowledge in the service of humankind.

*These same forces of intellectual harmony and exchange are now taking shape in the new Library of Alexandria (*Bibliotheca Alexandrina*), creating, in the words of Ismail Serageldin (TWAS Fellow 2001), its founding director, a global institution of culture, intellect and science that forms a "window for Egypt on the world and for the world on Egypt." In three short*

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years, the library has emerged as one of the world's great centres for learning and culture, providing a prologue for success in today's world of global knowledge.

It is for these reasons that TWAS welcomed Ismail Serageldin's invitation to have the Bibliotheca Alexandrina *host the Academy's 16th General Meeting, which took place from 29 November to 3 December 2005. Both TWAS and the library share a common goal to rekindle the vast yet largely untapped intellectual and scientific capacities of today's 'developing world', that same area which, some 2,000 years ago, at the time of Alexandria's grandeur, was the 'developed world'.*

Today's world, of course, is much different to the world of the distant past, not only in terms of the divide between the developing and developed world but also in terms of the unprecedented capacity of science and technology to drive rapid changes.

Science and technology have always been instruments of progress as well as tools of destruction, but never more so than today. Science and technology have always generated great wealth and great disparities in wealth. Science and technology have also brought people closer together and driven them farther apart – never more so than today.

Since its inception more than two decades ago, the main goal of TWAS has been to maximize the positive impacts of science and technology and to minimize the negative ones. During the first two decades of the Academy's existence, this largely meant focusing on scientific capacity building across the entire developing world from Chad to China and from Chile to Côte d'Ivoire. More recently TWAS has increasingly targeted its resources towards the least developed countries (LDCs) – the world's 50 poorest countries – where, not surprisingly, science and technology are lagging far behind.

This is not to say North-South parity in science has been achieved. Indeed if one adds up the scientific output of the entire developing world, where 75 percent of the world's people live, it amounts to just around 10 percent of the world's scientific output. When considering the top 1 percent of the world's noteworthy publications (that is, publications cited most often by other scientists in their articles, reports and books), then the developing world's contribution falls to less than 5 percent (compared to 60 percent in the United States, where just 4 percent of the world's population lives). In principle, if the developing world enjoyed equivalence in scientific output with the developed world, it would be authoring 75 percent of the world's scientific publications. One measure of short-term success would be for the developing world to produce 25 percent of the world's peer-reviewed scientific publications within the next 10 years.

These statistics remain a matter of deep concern for TWAS. But with the rise of Brazil, China, India and several other scientifically proficient developing countries, the Academy has every reason to believe that these percentages will improve. We should all be thankful for such progress but we should also recognize that progress thus far has been profoundly uneven, and that, while some developing countries have progressed rapidly, others have fallen even farther behind.

[CONTINUED PAGE 4]

It is for this reason that TWAS's deepest concern lies with the LDCs and why the Academy has launched a grants programme focusing on assisting research groups that operate in nations that are economically impoverished and scientifically lagging. To date, we have provided grants to nine research units in countries such as Ethiopia, Senegal, Sudan and Yemen.

At the same time, the Academy has decided to raise the target goal of the TWAS endowment from US$10 million to US$15 million (the endowment fund's balance now stands at US$8 million). By adding US$5 million to the endowment fund, together with the Italian government's generous annual contribution of US$1.5 million, we can help guarantee a stable financial future for the Academy and, simultaneously, help ensure that sufficient resources are on hand to address the most critical issues faced in the developing world without having to depend exclusively on external sources. A US$15 million endowment fund, simply put, would give us the strength and flexibility that we need to respond to the rapidly changing landscape for science in the developing world.

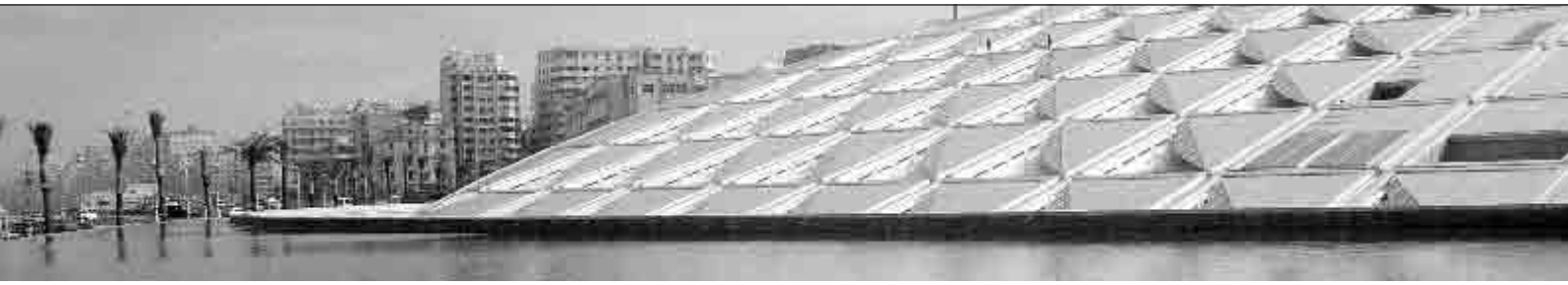
The ancient Library of Alexandria served as an intellectual and scientific hub during a turbulent era marked by such epic events as the fall of the Roman empire and the rise of Christianity. The new Library of Alexandria hopes to serve a similar role in an equally turbulent period marked by persistent and intense cross currents of culture that offer hope for improved international understanding while simultaneously generating high-levels of tension and spasms of unspeakable violence.

In the present era, even more so than in past, science and technology are irreplaceable elements propelling progress on a global scale. The Academy looks forward to standing together with the Bibliotheca Alexandrina *to promote strategies for science-based development that will mean so much to the Arab region and the rest of the world. Members of TWAS anticipate that the rigorous intellectual and scientific discussions that took place at the Academy's 16th General Assembly in Alexandria will mark the beginning of a long and productive relationship with the library, as both the institutions continue to lead the way for science capacity building and sustainable development that reach into all corners of the developing world.* ■

C.N.R. Rao
President
Academy of Sciences for the Developing World (TWAS)

KNOWLEDGE MEETS CULTURE IN BIBLIOTHECA ALEXANDRINA

EGYPT'S PRESIDENT MOHAMED HOSNI MUBARAK, WHOSE GOVERNMENT SERVED AS THE PRIME SPONSOR OF THE NEW LIBRARY OF ALEXANDRIA, GAVE THE OPENING ADDRESS AT TWAS'S 16TH GENERAL MEETING. IN HIS SPEECH, PRESIDENT MUBARAK OUTLINED HIS PLANS FOR SCIENCE IN EGYPT, PLACING IT AT THE CENTRE OF THE NATION'S ECONOMIC DEVELOPMENT EFFORTS.



Bibliotheca Alexandrina, *the new Library of Alexandria, which opened to the public just three years ago, has rapidly emerged both as a world-renowned institution of knowledge and an open forum for facilitating dialogue between cultures. As a sterling symbol of humanity's unquenchable thirst for knowledge, the library seeks, in the words of its lofty mission, "to honour the past, celebrate the present and embrace the future".*

It should therefore come as no surprise to learn that the new Library of Alexandria has been built near the site of the ancient Library of Alexandria, antiquity's greatest centre of learning and cultural exchange. Yet it is also important to note that the physical structure itself – a 'form-fitting-function' edifice of steel and glass that venerates light and free-flowing space – is an unabashed expression of modern architecture. Built on the foundations of ancient wisdom but reaching both metaphorically and physically towards the frontiers of knowledge, the new Library of Alexandria proudly expresses its bold themes of understanding and progress as timeless pursuits shared by all of humanity for all of humanity.

Science has always been – and never more so than in our modern world – a central element in this quest. And that is why the Egyptian government was proud to have the

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Academy of Sciences for the Developing World (TWAS) meet here for its 16th General Assembly. The more than 800 scientists from 90 countries who have been elected members of TWAS not only represent great individual scientific achievement but also reflect how the pursuit of science transcends political borders to foster intellectual creativity among all cultures as part of the common heritage of humankind.

Civil society has played a key role in the relentless reform and modernization of society through its pursuit, articulation and exchange of knowledge. As a key constituent of civil society, the scientific community has helped to spur change from the time of Archimedes in ancient Greece to our nuclear age inspired by the work of Albert Einstein.

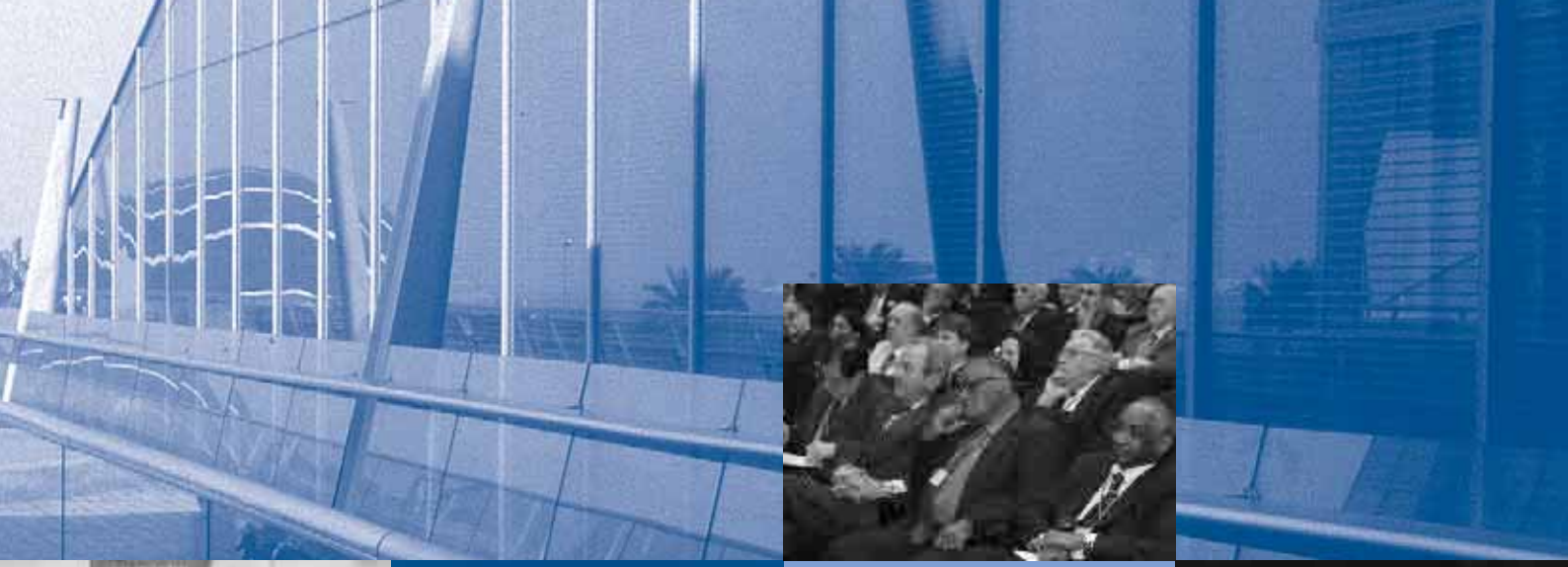
Science, therefore, is destined to play a fundamental role in the reform and modernization of the developing world in general and the Arab region in particular. Abdus Salam, the great Pakistani scientist and Nobel Prize winner in physics who also founded TWAS, understood science's importance to society and viewed it as a primary reason for the enormous disparities in living conditions between the developed and developing worlds.

Today, the gap remains prevalent – and indeed may be widening – in many fields of scientific endeavour, including such cutting-edge fields as biotechnology, information and communication technologies, alternative and renewable energy, medicine and the development of pharmaceuticals. Equally important, the gap also remains prevalent in scientific education and training, which will largely determine a nation's future scientific capacity and levels of accomplishment.

The critical importance of scientific education and training make the efforts of such institutions as the new Library of Alexandria and TWAS ever-more critical to both national and international efforts for achieving a better future for the people of the developing world.

Egypt is determined to strengthen its capacity in science by improving its scientific infrastructure and training and by expanding its efforts for scientific cooperation with other nations, particularly nations in the Arab region. We will seek to advance these goals by:

- Setting clear priorities and benchmarks for measuring progress.
- Fostering human resource development by strengthening the curriculum for science at the primary, secondary and tertiary levels.
- Improving the status of existing research institutions and building new institutions in geographical



areas and fields of interest where they do not currently exist.

- Enhancing cooperation between the public and private sectors for the financing and promotion of science.
- Expanding South-North and South-South scientific cooperation.

Progress on all of these fronts will require enormous investments – both political and financial – on the part of all developing countries.

Assistance from our friends in the developed countries is, of course, welcome. But success will only come to those who choose to help themselves. The greatest responsibility for achieving scientific parity with the developed world thus rests on the shoulders of the developing countries which must prove that they are capable of shouldering such responsibility as a long-term commitment that reaches beyond immediate rewards.

That is why Egypt has worked closely with the United Nations, the League of Arab States and the African Union – most recently on activities related to the UN sponsored World Summit on the Information Society (WSIS), which was held in Tunisia in November 2005 – to develop the scientific capacity of our nation and region, and that is why we will continue to strongly support the work of the new Library of Alexandria, which holds such promise for returning the Arab region to a pre-eminent position as a global centre for knowledge and cultural exchange.

Egypt and its flagship institution for knowledge and science – the new Library of Alexandria – look forward to working closely with TWAS on achieving these lofty goals, which will make for a more secure, peaceful and harmonious world. ■

Hosni Mubarak
President
Egypt

TWAS IN EGYPT LOOKING TO THE FUTURE

THE 16TH GENERAL MEETING OF TWAS TOOK PLACE IN ALEXANDRIA, EGYPT, FROM 29 NOVEMBER TO 3 DECEMBER 2005. SOME 250 SCIENTISTS FROM AROUND THE WORLD ATTENDED, THE MAJORITY OF WHOM WERE MEMBERS OF TWAS.

TWAS's 16th General Meeting was held at the Bibliotheca Alexandrina*, the new Library of Alexandria, completed in 2002, and a shining example of a forum for cultural dialogue and scientific exchange in one of the world's most troubled regions.*

Highlights of the meeting included:

• An address to TWAS Fellows by the President of Egypt, Mohammad Hosni Mubarak, in which he outlined Egypt's efforts to expand the base of scientific research through five main points: first, by developing policies for supporting scientific research; second, by developing human resources and improving all levels of education; third, by building new state-of-the-art and independent research centres while continuing to support the existing ones; fourth, by enhancing the relationship between the government, private and public sectors and civil society organizations to help finance scientific research; and fifth, by facilitating the transfer of technologies from advanced nations while creating North-South and South-South cooperation. (For the text of President Mubarak's address, see pages 5-7).

President Mubarak also presented the 2005 Trieste Science Prizes, the 2005 TWAS Medals and the 2004 TWAS Prizes to the awardees.

• A talk by Paula Dobriansky, the US Under Secretary of State for Democracy and Global Issues, who was in Alexandria to renew a ten-year agreement between the US and Egypt on cooperation in science and technology. "Over two thousand years ago" said Dobriansky, "Alexandria's ancient library was a centre of science and mathematics and a bastion of learning unlike any the world had ever known before. It brought together great minds to solve major problems – and it succeeded. Today, TWAS seeks to promote

NEW INITIATIVE

TWAS and the International Centre for Genetic Engineering and Biotechnology (ICGEB) have announced a joint programme to promote research in plant biotechnology in developing countries. The programme will support novel and innovative basic research in plant biotechnology and, in particular, on resistance to abiotic stress. Applications are being invited from two to four collaborating research groups located at institutions in different countries. Principal applicants should be located in ICGEB member states. Special consideration will be given to those applications that include at least one least developed country. Letters of intent to participate in the programme should be received by 15 February 2006. TWAS and ICGEB will then invite selected research groups to a 'match-making' symposium, to be held in May or June 2006, aimed at helping potential participants to develop their collaborative programmes. For additional information, visit www.icgeb.org/GRANTS/icgeb_twas.htm.

scientific excellence and recognize scientific accomplishments. It brings together great minds to solve major problems. The US stands with TWAS in this very important effort and hopes that, together, we will succeed."

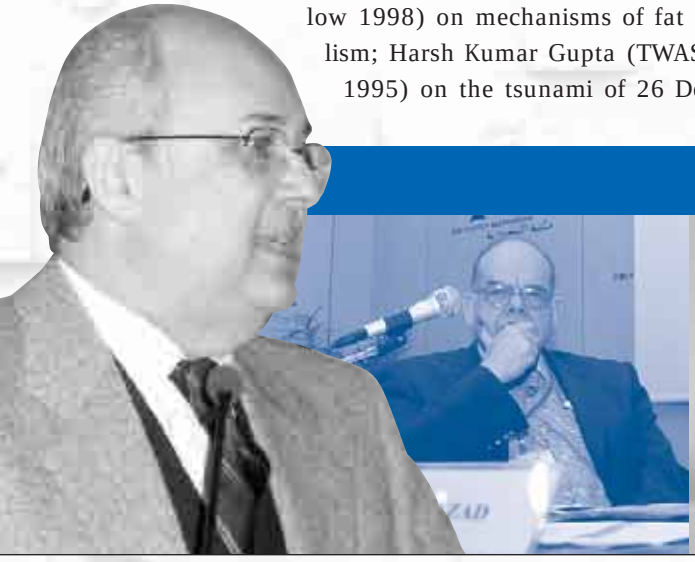
• Lectures by the two 2005 Trieste Science Prize laureates, Sergio H. Ferreira (TWAS Fellow 1993) and T.P. Ramakrishnan (TWAS Fellow 1991), as well as lectures by each of the eight 2004 TWAS Prize winners.

• TWAS Medal Lectures for 2005 were presented by Eugenia del Pino Veintimilla (TWAS Fellow 1989) on the developmental strategies of marsupial and dendrobatid frogs; and Ragunath A. Mashelkar (TWAS Fellow 1993) on how scientists are increasingly providing inert gels with life-like properties (see pages 29-34). In addition, special lectures were presented by Salih J. Wakil (TWAS Associate Fellow 1998) on mechanisms of fat metabolism; Harsh Kumar Gupta (TWAS Fellow 1995) on the tsunami of 26 December 2004 and India's subsequent initiative to mitigate the impact of future tsunamis and storm surges (see pages 40-43); Peter Raven (TWAS Associate Fellow 1993) on biodiversity, sustainability and developing countries; and Ismail Serageldin (TWAS Fellow 2001) on science in Egypt 'from Imotep to Zewail', the ancient and modern libraries of Alexandria, and women in science.

Alexandria's ancient library was a bastion of learning unlike any the world had ever known before.

• Fifty eminent scientists from 21 countries were elected to TWAS. The list included the first TWAS Fellow from Rwanda as well as scientists from countries under-represented in TWAS such as Ghana, Iran, Kenya, Madagascar, Nepal, South Africa, Sri Lanka and Uruguay. Successful candidates were chosen from a record 270 nominations. Total TWAS membership now stands at 811. For a complete list of the new members, see *www.twas.org* and click on the 'Membership' link.

• TWAS Council announced the following winners of the TWAS Prizes for 2005: Alex Enrique Bustillo Pardey, Colombia, in agricultural sciences; Huanming Yang,



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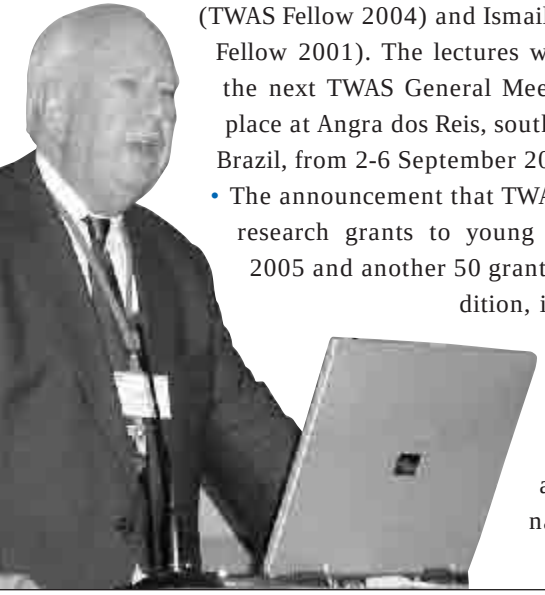
China, and Jerson Silva, Colombia, in biology; Krishna Ganesh, India, in chemistry; Rixiang Zhu, China, in earth sciences; Mauricio Terrones, Mexico, in engineering sciences; Parimala Raman, India, in mathematics; Shah M. Faruque, Bangladesh, in medical sciences; and Enge Wang, China, in physics. Among these, Mauricio Terrones, at age 37, is the youngest scientist ever to win a TWAS Prize, Parimala Raman is the first woman mathematician to be honoured by TWAS in the 20-year history of its awards schemes, and Shah Faruque is the first scientist from Bangladesh to receive a TWAS Prize. For additional information on these prize winners, visit *www.twas.org* and click on the 'Activities' link.

The Council also announced the TWAS Medal Lecturers for 2006: Eduardo Moacyr Krieger (TWAS Fellow 1995), Li Jiayang (TWAS Fellow 2004) and Ismail Serageldin (TWAS Fellow 2001). The lectures will be presented at the next TWAS General Meeting that will take place at Angra dos Reis, south of Rio de Janeiro, Brazil, from 2-6 September 2006.

• The announcement that TWAS had awarded 47 research grants to young scientists in early 2005 and another 50 grants in October. In addition, in partnership with TWAS, 23 Prizes to Young Scientists in Developing Countries were awarded by national science organizations in 15 countries in the South. It was also announced that TWAS had received some 130 applications for its various fellowship programmes and that successful candidates would be selected by the first TWAS Fellowships Committee that would meet in Trieste in December (see box, page 11). Commenting on the fellowship programme, TWAS secretary general, Jacob Palis, said that the aim was to award 200 fellowships a year. "In five years, this will amount to 1,000 young scientists going to some of the world's best institutions. If we do this well," continued Palis, "we will make a big difference, changing the map of science in the world in less than a decade."

The TWAS fellowships programme will make a big difference, changing the face of science in less than a decade.



• A special session on 'New Initiatives in Promoting Science Education and Research in Developing Countries' chaired by Ismail Serageldin and featuring Sergio Rezende, Brazil's Minister of Science and Technology among the panelists.

• A workshop on 'Social Sciences and Economics', convened by Ismail Serageldin. At the close of the workshop, it was decided to establish a task force, in collaboration with the Third World Organization for Women in Science (TWOWS), to devise a strategy for increasing the presence of women scientists in the global scientific community, especially at high-level administrative and management positions. The task force will be assembled by February 2006 and report back to the Academy at the next TWAS General Meeting scheduled to take place in Brazil in September 2006.

• A special session dedicated to the 'TWAS Perspective on the International Year of Physics', which celebrated

the centennial anniversary of Albert Einstein's *annus mirabilis*, 1905, the year Einstein published four seminal papers that revolutionized the study of physics and radically altered public perception of the universe. The workshop featured presentations by Claude Cohen-Tannoudji, the French Nobel Laureate in physics, 1997, who spoke on the modernity of Einstein's ideas; Luis Davidovich (TWAS Fellow 2002), who explored the subtleties of quantum mechanics; Govind Swarup (TWAS Fellow 1991) who looked at cosmology and astrophysics "from Einstein to now"; and Lu Yongxiang, president of the Chinese Academy of Sciences, who summarized the advances in physics made during the past 100 years (see pages 44-48).

• A special session dedicated to 'Biotechnology for Developing Countries', chaired by Manju Sharma (TWAS Fellow 1995). Workshop speakers outlined the impact of biotechnology in different areas of science, including agriculture, pharmaceuticals, diagnostics and the environment. At the end of the session, TWAS members present agreed to establish a standing panel on biotech-

FELLOWSHIPS PROGRAMMES

The first TWAS Fellowships Committee, comprising representatives from the organizations supporting the programme, met in Trieste for the first time on 8-9 December 2005. From the 130 applications received for the fellowship programmes, 81 awards were made: 47 by the Chinese Academy of Sciences (CAS), including 18 postgraduate students, 14 postdoctoral researchers and 15 visiting scholars; 29 by the Brazilian National Council for Scientific and Technological Development (CNPq), including 17 postgraduate students and 12 postdoctoral researchers. Among these 12 are the first two fellowships awarded by TWAS to young scientists from Iraq. In addition, the Department of Biotechnology of the government of India also awarded five fellowships, including 3 postgraduate students and 2 postdoctoral researchers. The awards will be taken up in 2006.

[CONTINUED PAGE 12]




nology issues, organizing capacity building and awareness raising programmes, and holding two or three workshops a year in different developing countries.

• The launch of a TWAS initiative to be carried out in collaboration with the International Centre for Genetic Engineering and Biotechnology (ICGEB). The initiative will encourage research institutions to develop collaborative research programmes in the field of plant stress (see box, page 9).

• An update on the TWAS Regional Offices, which are now operating in five regions of the developing world: in Beijing under the auspices of the Chinese Academy of Sciences for the east and southeast Asia region; in Bangalore under the Jawaharlal Nehru Centre for Advanced Scientific Research for central and south Asia; in Nairobi under the African Academy of Sciences for sub-Saharan Africa; in Alexandria under the *Bibliotheca Alexandrina* for the Arab region; and in Rio de Janeiro under the Brazilian Academy of Sciences for Central and South America and the Caribbean. The offices have held conferences and symposia, launched awards programmes for young scientists, developed websites, and publicized and distributed information about TWAS programmes both to scientists and scientific institutions throughout their regions.

We must create centres of excellence or we will continue to lose our talented scientists.

Despite the increasing visibility of the TWAS fellowships programme and the increasing number of nominations received for new fellows and TWAS Prizes, discussions during the TWAS General Meeting explored some of the areas where TWAS could be more effective. Once again, the main areas of concern were sub-Saharan Africa and the least developed countries (LDCs).

Sospeter Muhongo (TWAS Fellow 2004 and director of the International Council for Science (ICSU) regional office for sub-Saharan Africa) highlighted the fact that African universities had inadequate resources to host visiting professors and asked whether TWAS could devise a programme that would allow 'itinerant' lecturers to travel from one location to another, which could serve as another aspect of the Academy's core strategy for promoting scientific exchange. He also added that the TWAS fellowship programme was an excellent scheme, but that it needs to be more widely promoted in Africa.

Yousef Sobouti (TWAS Fellow 1987) highlighted the ongoing problem of the brain drain. "Whatever we do seems to exacerbate the brain drain rather than

IN MEMORIUM

TWAS lost seven members in 2005: ***Hubert Curien*** *(Associate Fellow 2002, France);* ***Ranjan Roy Daniel*** *(Fellow 1995, India);* ***Donald Efiong Udo Ekong*** *(Fellow 1985, Nigeria);* ***Tseng Cheng Kui*** *(Fellow 1985, China),* ***Huang Kun*** *(Fellow 1985, China);* ***César Lattes*** *(Fellow 1988, Brazil); and* ***Jalal Mohammad Saleh*** *(Fellow 1987, Iraq). We will miss their friendship and camaraderie and extend our condolences to their families and friends.*

MEETING NEXT

The 17th General Meeting and 10th General Conference of TWAS will take place at Angra dos Reis, 150 kilometres south of Rio de Janeiro, Brazil, on 2-6 September 2006.

During the meeting in Alexandria, it was decided that the conference in Brazil will feature a special session for young scientists. Participants will be selected on merit through an open competition. The young scientists, who will be mentored by TWAS Fellows, will be asked to discuss a series of issues revolving around how their scientific output can be used for national development.

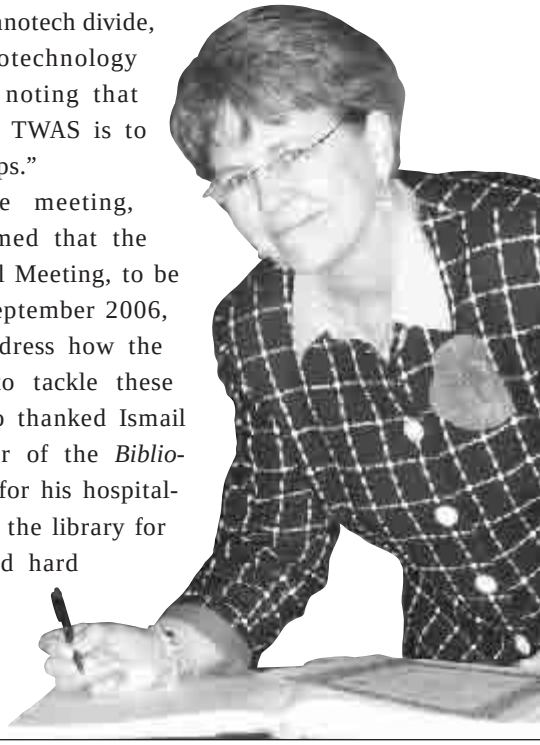
help it," he said. "We must create centres of excellence of substantial strength or we will continue to lose our talented young scientists as they become disillusioned and seek opportunities elsewhere."

Muhammad Iqbal Choudhary (TWAS Fellow 2002) added that, in those countries where science and technology is leading development, the driving force has been political will. He then suggested lobbying the leaders of developing countries.

Vincent Titanje (TWAS Fellow 2004) added that the grand challenges for TWAS included not only contacting international donor agencies to fund large programmes – a challenge also highlighted by the TWAS Programmes Committee during its discussions – but also to encourage countries to put their own money into their own national science budgets.

TWAS President, C.N.R. Rao agreed with these comments and added that TWAS, in collaboration with the InterAcademy Panel (IAP) is talking to government ministers, seeking to convince them of the importance of building indigenous scientific capacity as a major step towards economic development.

Summing up, Lu Yongxiang (TWAS Fellow 1990 and president of the Chinese Academy of Sciences) highlighted the fact that supplying even such basic needs in developing countries as safe drinking water and mitigating natural disasters are also high-tech challenges. "These issues should be considered alongside the other 'divides' such as the digital divide, the nanotech divide, the space and biotechnology divides," he said, noting that "the challenge for TWAS is to narrow all these gaps."



Concluding the meeting, C.N.R. Rao confirmed that the next TWAS General Meeting, to be held in Brazil in September 2006, will specifically address how the LDCs can begin to tackle these challenges. He also thanked Ismail Serageldin, director of the *Bibliotheca Alexandrina*, for his hospitality and the staff of the library for their assistance and hard work both before and throughout the meeting. ■

SCIENCE IN EGYPT

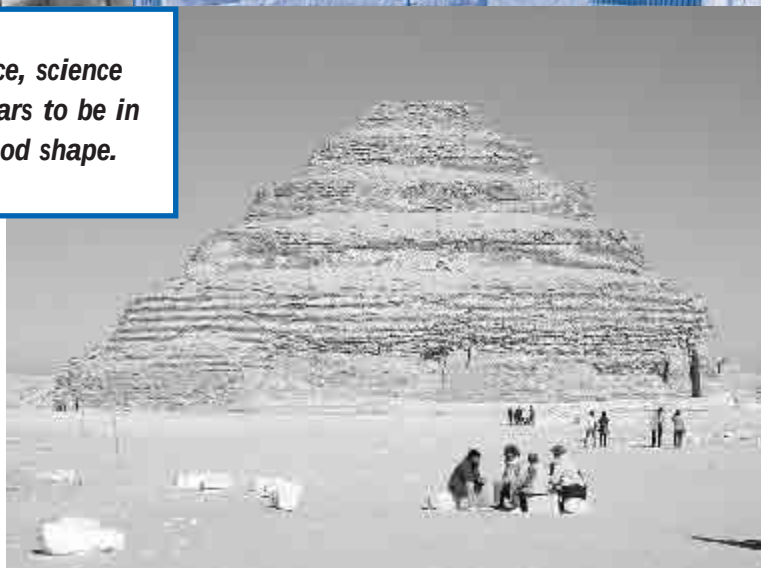
HOME TO ONE OF THE WORLD'S GREAT CIVILIZATIONS AND OFTEN VIEWED AS HAVING ONE OF THE ARAB REGION'S LARGEST AND STRONGEST SCIENTIFIC COMMUNITIES, EGYPT NEVERTHELESS FACES GREAT CHALLENGES IN MODERNIZING ITS SCIENCE AND TECHNOLOGY ENTERPRISE.

At first glance, science in Egypt appears to be in relatively good shape. There are, after all, about 170,000 scientists living and working in the country. That translates into 2,000 scientists per million population. Developing countries, in contrast, have on average only 800 scientists per million population – less than half of Egypt's percentage.

Respect for education within Egypt, moreover, has deep roots that date back to the time of the pharaohs some 5,000 years ago. Some 50 years ago, soon after Egypt gained independence from the United Kingdom, the newly formed Egyptian government declared that university education would be free and embarked on an extensive programme for scientific development based on the creation of publicly funded research centres in a broad number of disciplines. The result has been the creation of nearly 50 centres, including nine that TWAS currently designates as centres of excellence. And just three years ago, in 2002, the Egyptian government opened the doors of the new Library of Alexandria, which has become a beacon of knowledge not only in its host nation but throughout the Arab region.

Yet, as we all know, looks can sometimes be deceiving (or at least somewhat misleading) and that may well be the case in Egypt. Despite some favourable statistics and venerable institutions, Egypt faces great challenges in its efforts to build a scientific base that truly meets global standards for excellence.

Critics bitterly contend that the nation's research system suffers from bureaucratic inertia and an abiding sense that age trumps talent, making it difficult for young researchers to gain the support that they need to advance their careers. Cronyism often drives promotions and limited funds often fail to keep pace with inflation, leaving individual researchers underpaid and institutions poorly equipped and maintained. All of this has added up to an aging and lethargic scientific community. "Research in Egypt," as one critic recently



At first glance, science in Egypt appears to be in relatively good shape.

lamented, "is, as it always was, a haphazard activity."

But such discouraging trends may finally be experiencing a turn-around. Several recent developments, at least, point in that direction, providing hope for the future.

First, Ahmed Nazif, who holds a doctorate in computer engineering from McGill University in Canada, was appointed prime minister in July 2004. Less than one year after he assumed office, in June 2005, the Ministry of Scientific Research and the Academy of Scientific Research and Technology published a 12-year strategic plan for science and technology in Egypt. The plan – an action-oriented document that is intended to serve as one of the cornerstones of Nazif's reform efforts – was officially launched at a national science conference held in Cairo in June 2005 attended by more than 4,000 Egyptian researchers and science administrators.

Among its specific recommendations, the plan calls for the creation of postgraduate training programmes in such cutting-edge fields as biotechnology, renewable energy, pharmaceuticals and information and communication technologies. It also emphasises the need to develop a comprehensive strategy for the promotion of women in science; for the creation of better training programmes for science policy advisors; and for devising more effective ways of enhancing the public's appreciation and understanding of science.

These broad-based initiatives will be funded by raising the percentage of the government's budget devoted to science and technology from 0.9 percent to 1 percent. If this commitment is fulfilled, the annual level of funding available for science and technology initiatives will rise to an estimated US$8.5 billion by 2012.

As part of this larger effort, in late 2004, Egypt opened a 146,000 square metre complex in the shadow of the pyramids of Giza, which it dubbed a 'science and technology city'. The complex will have a continual series of interactive exhibits on display. It will also be responsible for producing and distributing print, broadcast and electronic material designed to bring science and technology closer to the people, not just in Cairo but throughout the nation. In a related effort, Egypt's science and technology city plans to hold conferences, symposia and training workshops to strengthen science communication.

In January 2006, again in line with its 12-year strategic plan for science and technology, the Egyptian

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Critics contend that the nation's research system suffers from bureaucratic inertia and an abiding sense that age trumps talent.

government announced that it would launch a fellowship programme for 50 African students a year, over the next 10 years, to study in Egyptian universities and research centres. The twin goals of the fellowship programme are to promote scientific capacity building in Africa and to encourage cooperation across the continent.

During the same month, Nazif appointed Hany Mahfouz Helal, professor of mineralogy at Cairo University, as both the Minister of Higher Education and the Minister of State for Scientific Research. Helal has been asked to strengthen public-private sector partnerships in science and technology, especially in the fields of nanotechnology, biotechnology and information and communication technologies.

Whether these recent steps lead to sustained investments in science and technology remains to be seen.

The existing foundation on which the nation will seek to build a more dynamic scientific enterprise was clearly visible at a session held at the TWAS 16th General Meeting in Alexandria, devoted to science and technology in Egypt. At the session, scientists from four of the nation's most esteemed scientific institutions described the range of activities currently being pursued by their institutions. Summaries of their presentations follow.

WATER MATTERS

Of all the resources needed for sustainable economic development, one may be more vital than all others: access to safe drinking water. This is especially true in the arid and semi-arid environments that dominate Egypt and the entire Arab region. That is why, in 1975, the Egyptian government created the National Water Research Centre (NWRC). It has since become one of the nation's pre-eminent centres of excellence.

Access to water has always been a vital concern to Egypt. Indeed it is no surprise that the ancient civilizations of Egypt embraced the Nile River both as a lifeline to their very existence and as an enduring source of their culture and spirituality. Water resources have become even more precious in recent years, not only in arid nations such as Egypt but throughout the entire world, as relentless population growth and increased levels of pollution add to the scarcity of water and raise the spectre of widespread shortages in the future.

To meet the increasing demand for water, even as additional stresses place current supplies at risk, Egypt must optimise the use of conventional resources while simultaneously exploring ways of accessing nonconventional sources. The government has taken this responsibility seriously. In 1981, it issued a water mas-

ter plan; in 1993, a water security plan; and in 2003, a water resources plan.

For the past three decades, NWRC, operating under the auspices of the Ministry of Irrigation and Water Resources, has been the nation's primary water resources research centre. The centre oversees 12 research units with mandates that range from such specific issues as coastal and ground water supplies to such cross-cutting challenges as engineering, construction and climate change.

NWRC's primary goal is to ensure that the research units functioning under its administrative umbrella are conducting strong and effective research programmes. NWRC has also established strong links both to international water organizations and water agencies in other countries. In addition, it acts as the coordinating unit for the African Water Resources Network and is a member of the water resources network in the Middle East and North Africa region.

Egypt's population currently stands at some 75 million and is increasing at a rate of more than one million a year. Historically, it is one of the few nations in the Arab region that has enjoyed adequate water supplies, thanks in large measure to the bounty of the Nile River.

Yet it now faces the prospect of water scarcities. That's due not only to population growth but also to rising levels of pollution caused primarily by uncontrolled municipal and industrial discharges into water ways, rising levels of water salinity related to irrigation, and natural saltwater intrusions emanating from silt in the Nile Delta.

Combatting these ominous trends requires both good science and good management. That's why NWRC and its research units focus not only on basic research but also on analysing, for example, effective strategies for the development of integrated resource management programmes and on examining how environmental laws and regulations at all governmental levels can be more effectively enforced.

Experience has shown that recent advances in remote sensing and computer modelling can help create a framework for dramatic improvements in water resource use and conservation. At the same time, experience has shown that the most effective programmes, without exception, are demand-driven and client-based.

Providing the technical underpinnings to ensure adequate water supplies remains a primary responsibility of the NWRC. But, over the past decade, more and more attention has been paid to questions of water quality and the long-term environmental impacts associated with such water management issues as irrigation.

As a consequence of these trends, NWRC has evolved from largely technical, apolitical organization to an organization that devotes an increasing amount of its budget and attention to examining the policy relevance – and effectiveness – of its research.

Along with embracing new scientific tools and methodologies, NWRC has also adopted such new management approaches as 'logical framework analyses' and 'results-based management'. Indeed these institutional reforms, based on openness, transparency and accountability in decision making, are designed to strengthen the research management process. Specifically, the NWRC's reform measures provide decision makers with relevant and understandable information that help them devise science-based solutions to Egypt's critical water challenges.

About 90 percent of Egypt's overall budget for water research and development comes from the government and 10 percent from the private sector. That's exactly the opposite of the breakdown in developed countries, where on average 90 percent of all revenues for water research and development comes from the private sector and just 10 percent from the government.

As NWRC has shifted its agenda towards applied research, the research that it conducts has become more expensive. That's because its effectiveness depends on rigorous career-long training of personnel; continual

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upgrading of research tools; and the need to field test research findings – all of which isn't cheap. At the same time, competing demands on government and high public debt have made it increasingly difficult for NWRC to secure the funds that it needs.

As a result, NWRC has embarked on a strategy designed to secure funds from external sources that include, for example, international organizations and foundations, government agencies in the Arab region, and even private corporations. It does this by offering consultancy and project management services and organizing fee-based workshops and seminars. The goal is not to wean NWRC from its close and fruitful relationship with its prime benefactor, the Egyptian government, but to generate sufficient external funds to upgrade and sustain its research capabilities. The initiative, if successful, should prove advantageous to NWRC, Egypt and the entire Arab region. ■

For additional information about Egypt's water policies and the role that science and technology play in national efforts to maintain adequate water supplies, contact:

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SPACE OBJECTIVES

Remote sensing and space science may seem like technological luxuries that developing nations cannot afford given their pressing problems and limited financial resources.

But the fact is that Egypt and other developing nations must invest in these 'enabling' technologies if they hope to successfully address the critical environmental and economic challenges that they face – both now and in the future.

That is why the Egyptian government established a National Centre for Remote Sensing in 1971. Sixteen years later, in 1997, the government expanded the responsibilities of the centre to include space science. To more accurately reflect this new broader mandate, the organization's name was also changed to the National Authority for Remote Sensing and Space Sciences (NARSS).

The long-standing goal of NARSS has been to develop and maintain state-of-the-art laboratories for advanced image processing and applications. Since 1997, NARSS has also served as the primary government agency for building research and technological capacity in the fields of space science and for acquiring and operating ground stations able to receive and process a steady stream of space images. Throughout its history, NARSS has also focused on high-level train-

ing for its staff and forging broad-ranging collaborations with space agencies in other nations.

The remote sensing activities of NARSS are based on downloading images generated by satellites and on utilizing digital mapping systems capable of transforming these images into usable data on the ground. The organization's work has provided invaluable tools for investigations into the state of Egypt's natural resource base – most notably, its air, soil and water.

The nation's remote sensing capabilities have also played a vital role in devising strategies for urban and rural development and coastal and desert management. Most recently, remote sensing has been used to study trends in the nation's groundwater supplies and the potential impact of global warming on the nation's fragile ecosystems.

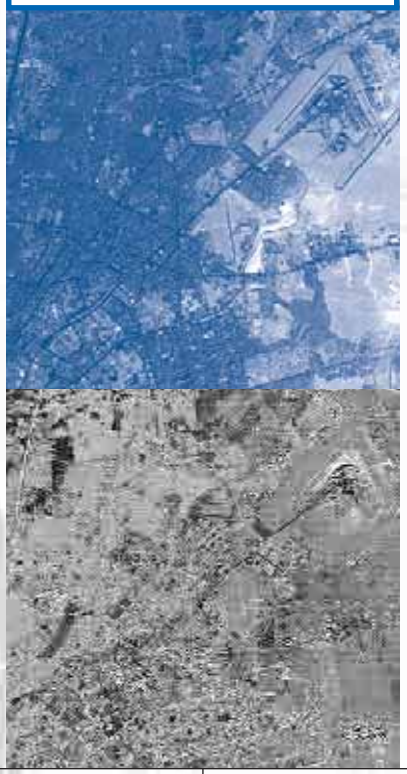
NARSS' space science activities, on the other hand, have largely focused on building the scientific know-how and technical infrastructure – in terms of engineering, materials, sensors and instruments – that are necessary for Egypt to develop 'self-standing' capabilities in space. The strategy calls for the development of 100-kilogramme micro-satellites – EGYPTSAT-1 for multi-spectral earth observation and DESERTSAT for desert exploration.

To ensure the successful launch of these satellites, NARSS is currently building a series of laboratories required for satellite design, assembly and testing. These laboratories are expected to be operational within the next three to four years, enabling Egypt to move from the purchasing to the manufacturing of satellites. In a sense, NARSS has been charged with the responsibility of transforming an off-the-shelf technology, acquired from others, into an indigenous technology based on home-grown scientific knowledge and technical skills.

While the success of the NARSS space science programme can only be judged in the future, the work of NARSS' remote sensing division is already bearing fruit. NARSS' remote sensing activities have proven instrumental in efforts to improve the nation's soil and water management programmes. The authority's information-gathering initiatives, which it hopes to expand substantially in the years ahead, have also provided an extensive database for government programmes to protect the nation's vast desert environment and to utilize wisely the bountiful yet largely untapped resources contained within this arid environment. Fisheries and agriculture have also benefited from NARSS, as have emergency measures to minimize the destructive impact of oil spills.

So, while sceptics may claim that Egypt's limited financial resources should be devoted to immediate social and economic problems, NARSS, over its three decades of operation, has proven that remote sensing is not so remote and that satellite technology is not so pie-in-the-sky when it comes to addressing the critical concerns of people. ■

The annual level of funding available in Egypt for science and technology initiatives will rise to an estimated US$8.5 billion by 2012.



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LANDFALL

Nature has bestowed on Egypt about 2.2 million hectares of arable land. Virtually all of it is confined to the Nile basin and delta and virtually all is dependent on irrigation water drawn from the Nile. Another 1 million hectares has been reclaimed from the Nile basin and delta thanks to sophisticated drainage

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and hydrologic engineering efforts that have been in place for decades. Then there are small scattered patches of rain-fed land – about 800,000 hectares – lying on the Mediterranean coast and nestled alongside groundwater-fed oases sprinkled across the vast arid regions that dominate the Egyptian landscape.

Adding all of this together, Egypt has about 3.3 million hectares of arable land. That represents less than 4 percent of the nation's total land area, which stands at about 100 million hectares. In contrast, Turkey, which covers an area of about 80 million hectares, has more than 23 million hectares of arable land. That means nearly 30 percent of Turkey's total land mass is available for agricultural use. Both countries are home to about 70 million people and both are experiencing rapid population growth.

All of these statistics mean that if we examine the challenges confronting Egyptian agriculture, we invariably wind up focusing, first of all, on its limited arable land base; secondly, on its large population that is growing at the rate of more than 1.2 million people a year; and, thirdly, on the Nile River, which is the nation's only significant source of fresh water.

Simply put, Egypt has a lot of mouths to feed and not a lot of land on which to grow food. That's why the Egyptian government decided to invest in biotechnology, establishing an Agricultural Genetic Engineering Research Institute (AGERI) in Giza in 1990.

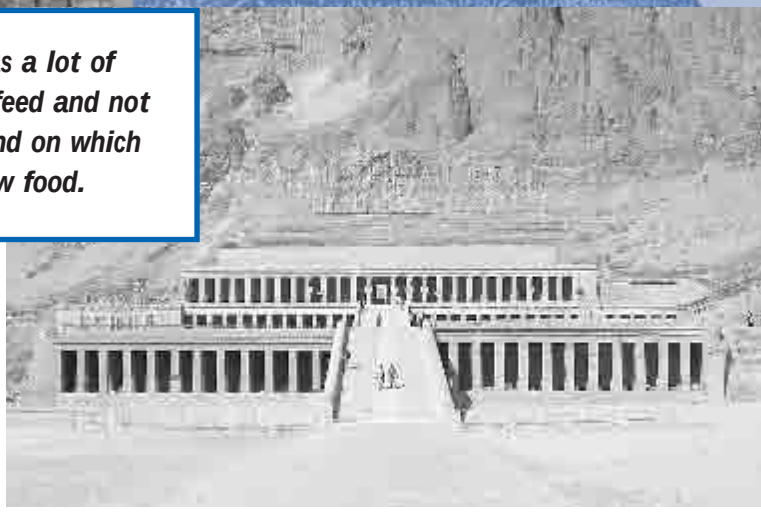
The institute's mission is to develop biotechnology products and services that will not only help foster a sustainable agricultural system within Egypt but ultimately create agricultural products and services that find their way into the global market place. In brief, AGERI has been asked to help build a scientific foundation for feeding Egypt's growing population while, at the same time, serving as a source of agricultural exports. As Anaya Itribi, director of the institute, noted at the TWAS General Meeting in Alexandria, AGERI "applies genetic engineering with one eye on the market."

Specifically, the institute focuses its research strategy on issues of prime importance to Egyptian agriculture. For example, it has sought to use biotechnology as a tool to develop genetically engineered plants more tolerant to prolonged drought, scorching heat and high levels of salinity (the latter is an unwelcome by-product of irrigation-dependent agriculture and the intrusion of saltwater into the Nile delta).

The institute is equipped with a state-of-the-art genomics and bioinformatics laboratory. Its first product, which has undergone field tests for the past five years, is a virus-resistant, genetically-modified squash, developed in cooperation with Michigan State University in the United States. Researchers at the institute have also worked with Montana State University in the United States on a project that has transferred a *Bt* gene into local potato varieties to make them more resistant to troublesome tuber moths, both in the field and in storage. Tests have shown that this biopesticide has led to a marked reduction in moth infestation and a corresponding increase in yield – all without the use of toxic pesticides. In addition, the institute has inserted the *HB1* gene into locally grown wheat, a bioengineering process that is designed to enhance plant yields in hot, dry conditions.

The *Bt*-modified potato has been exported with some success. The squash plant is undergoing additional tests to determine if it meets international biosafety standards for food, feed and environmental protection. However, because the market is small – no more than 120,000 hectares in Egypt are expected to be planted in squash – the regulatory process has proven to be costly in light of the anticipated return on the investment.

On the other hand, the institute is optimistic that *HB1*-containing wheat varieties will be introduced into the market much more rapidly and for less cost than the engineered squash plants because the introduced *HB-1* gene was isolated from a barley plant that is already deemed safe. Field tests, moreover, show that yields are 10 to 20 percent higher than yields obtained



Egypt has a lot of mouths to feed and not a lot of land on which to grow food.

from conventional wheat plants, making farmers eager to have access to the new varieties.

Other crops that have received AGERI's attention and resources include high-yielding transgenic cotton, which has been developed in partnership with the US agri-company Monsanto and which is projected to be on the global market by 2008, and virus-free transgenic sweet potatoes and virus-free strawberries which are being developed in cooperation with Egyptian food-exporting companies. The institute has also recently signed a contract with a cut-flower company in Egypt to create blue-coloured gerbera by isolating and transferring a gene from a blue-coloured petunia.

Other potential sources of external revenue for AGERI focus on the possibility of serving as a training centre for molecular biologists from the Arab region and on providing expert for-fee advice on such issues as technology transfer and the protection of property rights. All of these efforts are intended to generate funds that will be reinvested in the institute to help ensure that it keeps pace with rapidly evolving fields of biotechnology and genetic engineering. ■

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TISSUE CULTURE

Can medical science advance to the point where it could recreate human cells and tissues on a scale that regenerates skin, bones and organs? Such advances would likely prove a life-transforming event for a teenager who has lost a limb in a motorcycle accident or an aging widow who is suffering from bone-deteriorating osteoporosis.

The short answer is 'yes', we can recreate human cells and tissue, and rapid and encouraging progress is being made on this front. Nevertheless, we must also acknowledge that we have a long way to go before we can transform such ground-breaking efforts into routine procedures.

Continual advances in this cutting-edge field of medical research must focus on enhancing our understanding of how humans create 'real' tissues and then devise means to duplicate this natural process to mimic the 'architecture of life'. That is exactly the research agenda that has been embraced by Alexandria University's Tissue Engineering Laboratories.

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Scientific institutions in developing countries need not sit on the sidelines when it comes to the most advanced fields of science.

Life begins with molecules, which display one set of characteristics when existing in singular isolation and an entirely different set of characteristics when clumped together to create proteins, genes and cells. Such diverging characteristics are representative of nature's abiding commitment to bio-form and -function.

Medical researchers have successfully separated and then harvested cells and tissues – for example, from a person who has been badly burned. These harvested cells and tissues are then placed in an *in vitro* environment conducive to growth where they replicate millions of times to eventually assume the scaffold or matrix of 'real' tissue. At a certain point, the cells and tissues are grafted onto the wounded area where they continue to regenerate and ultimately rejoin the 'real' tissue – in effect becoming 'real' themselves. Such procedures – cell and tissue harvesting, seeding, growing, scaffolding and grafting – are now commonplace, and have aided millions of accident victims and casualties of war across the globe.

Could the same technique be successfully applied to those who have diabetes? Could we regrow a healthy pancreas – cell by cell, tissue by tissue? Will medical researchers eventually find a way to replicate the cells that constitute arteries and veins and then return the regrown cells to the body to replace blood vessels that have suffered seemingly irreparable damage? And what about procedures that enable us to regenerate bones and ultimately to regrow lost limbs? The key is to build a 'right-fitting' tissue scaffold or matrix that can align precisely – and then reconnect – to the body's real tissue. The process is called tissue engineering and recent advances are turning this pipe dream into a potential reality.

The scaffolding required for success can either come from a person or a tissue bank, or it can be created synthetically (for example, from seaweed, as has been done at the Tissue Engineering Laboratories). The key is to develop a specific and resilient structure that can serve as a host for the regenerated tissue and allow that tissue to grow in ways that are compatible with its ultimate location. Scientists at the Tissue Engineering Laboratories have successfully pursued this painstaking technique to regrow bone marrow that will aid dental surgeons in their efforts to reconstruct damaged and diseased gums.

The work of the Tissue Engineering Laboratories, which has accelerated over the past decade and particularly over the past five years, has led to the building of a state-of-the-art tissue engineering laboratory at Alexandria University, located on the top floors of the school of dentistry. Well-trained staff are now undergoing advanced training in a well-equipped laboratory in a place that just five years ago was plagued by peeling paint and broken table tops.

In 2006, the Tissue Engineering Laboratories will hold its first international workshop on tissue engineering, marking the institution's official debut on the global scientific field. By investigating ways to regenerate skin, bones and organs, the Tissue Engineering Laboratories is proving that scientific institutions in developing countries need not sit on the sidelines when it comes to the most advanced fields of science – fields that stand between the world of dreams and the world of discovery. ■

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ALEXANDRIA THE LIBRARY

IN JUST THREE BRIEF YEARS, BIBLIOTHECA ALEXANDRINA, SITE OF TWAS'S 16TH GENERAL MEETING, HAS EMERGED AS ONE OF THE WORLD'S GREAT CENTRES OF LEARNING AND INTER-CULTURAL DIALOGUE.

It is more than a library. It is also a conference centre, a museum complex, an exhibition hall, a planetarium and a state-of-the-art electronic information centre.

Indeed, *Bibliotheca Alexandrina* (the new Library of Alexandria), which was built near the site of the ancient Library of Alexandria, is a worthy successor to that world-famous institution, which stood at the apex of global learning some 2,000 years ago. Since opening in October 2002, following a decade of consultation, planning and construction, *Bibliotheca Alexandrina* has drawn nearly 200,000 visitors. Besides a variety of exhibitions, seminars, festivals and even concerts of national interest, the library has also hosted numerous international events, including TWAS's 16th General Meeting last December, which was attended by some 250 scientists from around the world. The library's director, Ismail Serageldin, and two of the library's trustees, Farouk El-Baz and Ahmed H. Zewail, are members of TWAS.

Bibliotheca Alexandrina's lofty goals are conveyed by its mission statement. Articulated well before the first visitor entered the building, the statement continues to guide the library's policies and programmes.

Bibliotheca Alexandrina, in the words of the institution's advocates and sponsors, is to serve as:

- The world's window on Egypt.
- Egypt's window on the world.
- A leading institution of the digital age.
- A vibrant centre of dialogue and understanding.

As Suzanne Mubarak, the wife of Egyptian President Hosni Mubarak and the guiding light behind the library's creation and development, observes: "The *Bibliotheca Alexandrina* seeks nothing less than to recapture the spirit of the ancient Library of Alexandria, the centre of knowledge and ecumenism in the ancient world, and to do so at the beginning of the third millennium, in the age of the internet and instant communication."

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How does this 40,000 square metre complex, which rests alongside the east harbour of Alexandria, hope to achieve its diverse and lofty goals?

First, there is the main library itself, which occupies seven floors and currently holds two million volumes (it has the capacity to hold four times as many volumes). There are also a number of specialised libraries that include the Taha Hussein Library for the blind and visually impaired; the Children's Library (for students between the ages of 6 and 12); the Young People's Library (for students between the age of 12 and 16); and the Arts and Multimedia Library, which currently contains 50,000 multimedia items (including CDs, DVDs and audio and video tapes). There are also interactive workstations and screening rooms designed to bring a wealth of audio and visual information to those eager to study all facets of human experience and endeavour. In addition, there is an Electronic Resources Centre, focusing on information available on the internet, as well as an Internet Archive that contains millions of web pages produced between 1996 and the present.

The* Bibliotheca Alexandrina *seeks nothing less than to recapture the spirit of the ancient Library of Alexandria.

Bibliotheca Alexandrina also provides space and sponsorship for a series of museums, including an Antiquities Museum, a Manuscript Museum and a Science Museum, as well as a series of research centres that currently consists of a Mediterranean Research Centre, a Calligraphy Centre, a Centre for Special Studies and Programmes, a Manuscript Centre, an Arts Centre and a National Centre for the Documentation of Cultural and Natural Heritage.

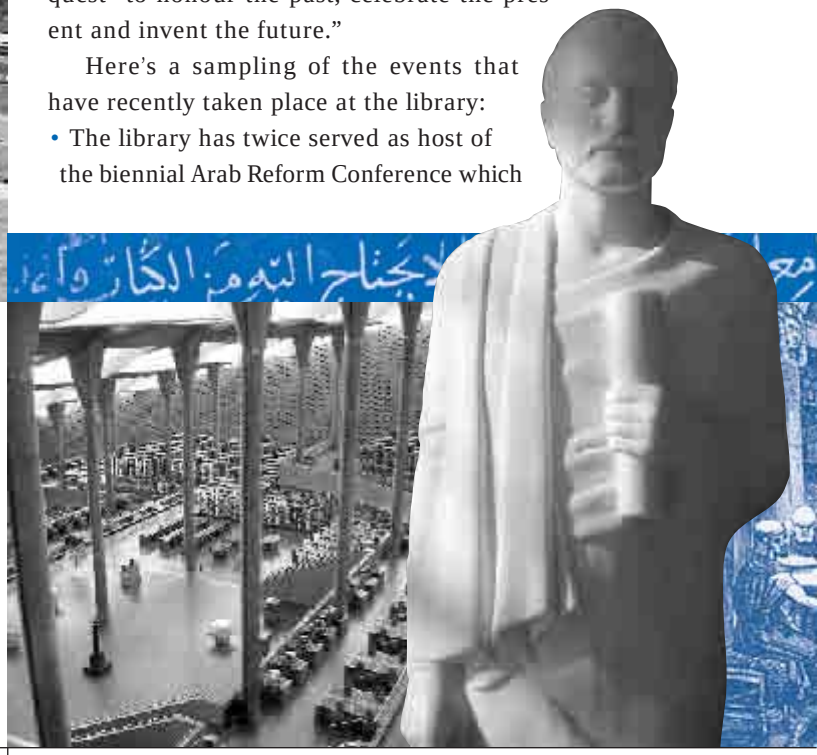
In addition, there is a Planetarium and Exploratorium which have drawn more than 70,000 visitors over the past three years. Many of these visitors have been school-age children seeking to learn more about astronomy, space and, increasingly, a broad range of other scientific fields.

Finally, there is the library's conference centre with a main hall that can accommodate up to 3,000 guests and ancillary meeting rooms and exhibition areas. This part of the complex has been the site of an increasing number of regional and international conferences and workshops, among which was the 16th General Meeting of TWAS.

The multi-dimensional nature of *Bibliotheca Alexandrina* is a fitting tribute to the legacy of the ancient Library of Alexandria, which, like its worthy successor, was also more of a dynamic crossroads of cultural exchange and discussion than a sedate sanctuary of scholarship. As the library's director, Ismail Serageldin, notes, *Bibliotheca Alexandrina* represents a quest "to honour the past, celebrate the present and invent the future."

Here's a sampling of the events that have recently taken place at the library:

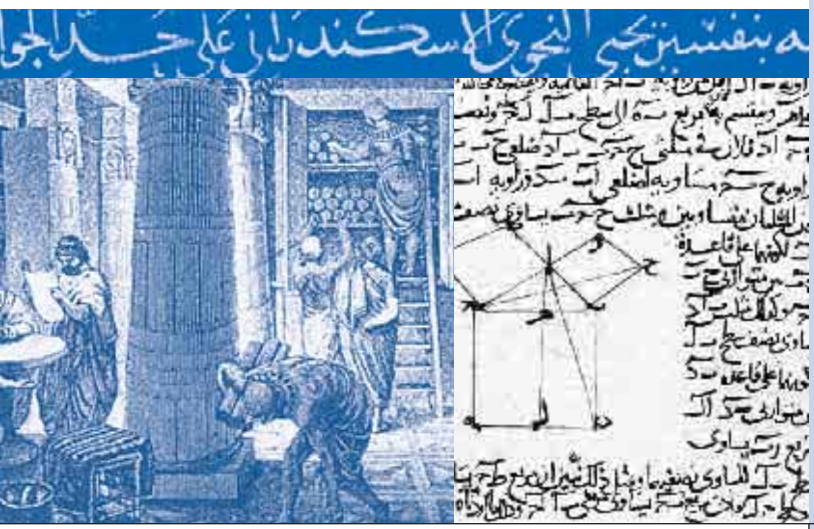
- The library has twice served as host of the biennial Arab Reform Conference which



brings together leading Arab intellectuals and representatives of civil society.

- In April 2004, the library, in cooperation with the World Life Science Forum, hosted *BioVisionAlexandrina*, an international conference examining the current state of biotechnology and, more generally, the life sciences, with special attention to issues of importance to the developing world. This biennial international conference, which is a companion event to *Biovision* held every other year in Lyon, France, will return to Alexandria in 2006. For additional information, see *www.bibalex.org/bioalex2006conf/*.
- In April 2005, *Bibliotheca Alexandrina* also hosted the Ann Lindh Euro-Mediterranean Foundation Conference for Dialogue Between Cultures and, in May, the Middle East Librarians Committee (MELCOM).
- In June 2005, the library sponsored the Einstein Symposium in honour of the World Year of Physics 2005, a year-long international celebration of Albert Einstein's *annus mirabilis*.
- And in February 2006, it held a conference marking the launch of the Peace Studies Institute, a joint venture between *Bibliotheca Alexandrina* and the Suzanne Mubarak Women's International Peace Movement.

It would be impossible to detail the full range of activities now taking place at *Bibliotheca Alexandrina*. Perhaps, by detailing two of its major initiatives – one celebrating the future, the other the past – observers can gain a sense of the breadth and sweep of what is taking place there.



THE FIRST AND ANCIENT LIBRARY

The ancient Library of Alexandria was more than a place of quiet study and contemplation. Indeed the library and its associated museum, which flourished for some 600 years from 300 BCE (before the common era) to 300 CE (the common era), in many ways forever changed the way in which intellectuals studied and presented ideas, transforming such endeavours from isolated, individual pursuits into well-known activities that could impact society and culture in untold ways. Its emphasis on all mindful pursuits – architecture, art, music and science – gave concrete expression to the unity of all thought and helped to solidify the importance of the relationship between abstract ideas and concrete action. The library, for example, was the site of the poetry of Callimachus and the musings of Theocritus. And it was a place that recorded and archived ancient Greek and Roman literature and science at a time when the West was turning its back on its heritage. Thus the ancient Library of Alexandria served as an irreplaceable bridge between the age of antiquities and the Renaissance – a beacon of light during Europe's Dark Ages. It was also the centre of global science at a time of great ferment and discovery. The library's Aristarchus, for example, was the first scientist to conclude that the Earth revolved around the sun; Erastothenes proved the Earth itself was spherical and calculated its circumference within one percent of its actual measurement; Euclid wrote his great treatise on geometry; and Herophilos accurately described the function of the organs, recognized the brain as the centre of human thought and reason, and calculated the systolic and diastolic pulse. But the library's contributions extended well beyond science. It was here, for example, that Manetho chronicled the history of Egypt under the pharaohs and classified their dynasties; that Callimachus catalogued books by topic and author laying the foundation for modern library science; that untold literary scholars and translators carefully edited the Greek classics, most notably the works of Homer. The ancient Library of Alexandria was, in short, a place that served as the intellectual crossroads for eastern and western cultures, helping to preserve and nourish the full range of human knowledge and experience at a time of great flux and uncertainty. It is this spirit – based on the ideals of tolerance, diversity and openness and driven by a commitment to rationality, debate and scholarship – that serves as the cornerstone of the new Library of Alexandria.

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THE ALEXANDRIA DECLARATION

Forces of change are challenging every aspect of Arab society. Over 50 percent of the 300 million people who live in the Arab region, which stretches from Oman in the east to Morocco in the west, are under 25 years of age. Internal tensions and external pressures have assured that dramatic change is inevitable. The issue is whether that change will be channelled into positive directions or whether the region will continue to be racked by endless dismay and violence. The Alexandria Declaration, which was approved by more than 160 participants at a conference held in Bibliotheca Alexandrina *in March 2004, introduced an Arab reform agenda that would respect and seek to integrate tradition into the present and indeed to draw on the region's rich, yet often neglected, tradition of rationality and progress to launch a better future. The reform agenda would be based on a critical approach designed to interpret tradition in contemporary terms and would be open and tolerant of contrarian views. For the full text of the Alexandria Declaration, which explores issues ranging from human rights to youth employment to family education to the role of science in society, contact:* secretariat@bibalex.org.

Embracing the Future. With state-of-the-art broadband connections, 330 public work stations and some 50 servers, *Bibliotheca Alexandrina* arguably has the best information and communication technology (ICT) infrastructure in Egypt and one of the best in the Arab region.

Beyond its first-rate infrastructure, the library actively participates in an array of ambitious ICT projects in collaboration with other leading institutions around the world. *Bibliotheca Alexandrina*, for example, serves as a 'mirror site' for the Internet Archive, which provides a 'snapshot' of every web page produced and posted on the internet since 1996. The archive now contains more than 10 billion web pages – a number that is growing dramatically with each passing day. *Bibliotheca Alexandrina* also participates in the Million Book Project. Led by Carnegie Mellon University in the United States and with partners in China, India and the USA, this project hopes to create a universal digital library by digitizing one million books by 2008, ultimately 'publishing' the books as a searchable collection on the internet.

Dealing with documents closer to home, *Bibliotheca Alexandrina* has joined Yale University, United States, and 16 other institutions in Germany, Jordan, Lebanon, Syria and the USA as part of the Online Access to Consolidated Information on Serials (OACIS) project for the Middle East. The goal is to improve access in the United States, Europe and the Arab region to collections found in Middle Eastern libraries, and to make scholarly literature about the Middle East more widely available to scholars around the world.

In addition, *Bibliotheca Alexandrina* has spearheaded the revival of the *l'Institut d'Egypte*, first built by Napoleon Bonaparte in Cairo more than 200 years ago. The cornerstone of this effort has been the creation of a digital version of the *Description de l'Egypte*, a comprehensive account of Egypt written by a legion of scholars and scientists – more than 150 in all – who travelled with Napoleon when he invaded Egypt in 1798.

The library has also organized the first digital archive of the papers, speeches, photos and videos of Gamal Abdel Nasser, the President of Egypt from 1954 to 1970 and the leading voice for pan-Arab unity.

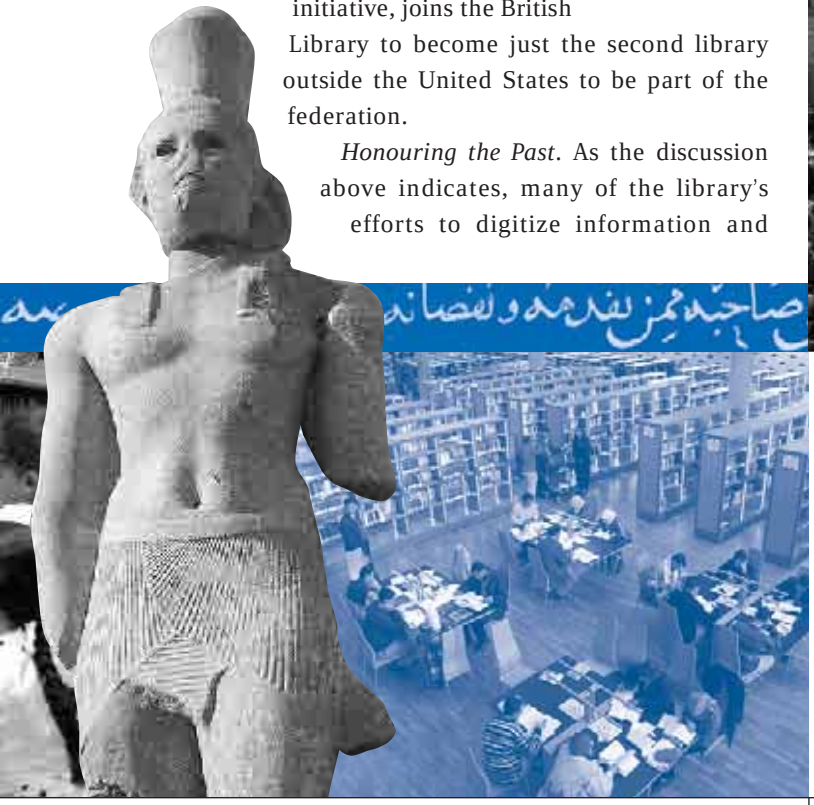
For its 'digital' achievements, *Bibliotheca Alexandrina* has been invited to become a strategic partner of the Digital Library Federation, an organization of more than 30 eminent academic libraries that are pioneering the use of electronic information technologies for providing greater accessibility to their collections and services. *Bibliotheca Alexandrina*, which will be responsible for digitizing monographs written in Arabic as its major contribution to this initiative, joins the British Library to become just the second library outside the United States to be part of the federation.

Honouring the Past. As the discussion above indicates, many of the library's efforts to digitize information and make it available on the web has focused on information that sheds light on the history of Egypt and the Arab region.

It is worth noting, however, that efforts by *Bibliotheca Alexandrina* reach well beyond such flagship projects as *l'Institut d'Egypte* and OACIS for the Middle East to include a diverse set of programmes designed to document and preserve both Egypt's and the Arab region's cultural heritage.

The Centre for the Documentation of Egypt's Cultural and Natural Heritage (CULTNAT), for example, seeks to preserve the long sweep of Egyptian history – from the time of the pharaohs to the present. The centre seeks to advance this goal by creating digital maps of Egyptian archaeological sites and digital renderings of the nation's most significant architecture, as well as by creating state-of-the-art archives for Egyptian music, photographs and manuscripts. Plans are also underway for electronically documenting Egypt's Islamic and Coptic (Christian) heritage. To ensure information is as widely accessible to the public as possible, the collections will be made available on a trilingual website (Arabic, English, French).

The library's efforts to digitize information have focused on information that sheds light on the history of Egypt and the Arab region.



In collaboration with the nation's Supreme Council of Antiquities and the multinational computer company IBM, the library has developed a unique internet portal that guides browsers through a historic cyber-tour of Egypt from ancient times to the present. In partnership with the Strabon Programme, which seeks to raise pub-

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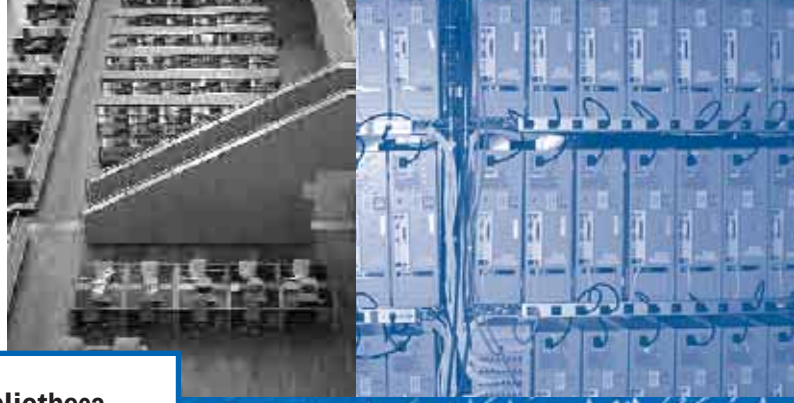

lic awareness of the cultural heritage of the Mediterranean basin, the Alex-Med Strabon project, sponsored by the *Bibliotheca Alexandrina*, plans to create a digital reconstruction of the Pharos Lighthouse, one of the seven wonders of the ancient world; the Ottoman mosques; and Qait Bey Fort, a 15th century structure built on the site of the Pharos Lighthouse, destroyed by the Turkish forces in the 16th century and by British forces in the 19th century and rebuilt both times.

Let the* Bibliotheca Alexandrina *serve as a place where minds can meet and ideas can flow.

The Calligraphy Centre and Manuscript Centre have worked together to digitize and archive the multitude of writings and translations produced during the 600-year history of ancient Alexandria, and to record, transcribe and translate the unpublished inscriptions found on the approximately 500 monuments built in Alexandria in the Pharaonic, Greek and Islamic periods. The Alexandrina Rare Collection Series, titled *Alexandrina Works*, has thus far restored 221 rare books, 27 manuscripts and five rare maps. It has also prepared a catalogue of 569 manuscripts focusing on Arabic grammar, language and morphology.

As Serageldin proudly proclaims: "Let the *Bibliotheca Alexandrina* be a space of freedom where we celebrate our cultural diversity and build bridges of understanding between peoples and civilizations. Let all those who believe in the best of the human spirit, in the value of knowledge and learning, in the rationality of argument and in the civility of discourse, make this institution their own" – revelling in the library's ability to serve as "a place where minds can meet and ideas can flow". ■

SCIENCE IN THE LIBRARY

The centrepiece of Bibliotheca Alexandrina*'s efforts to promote 'the culture of science' is the Planetarium and Exploratorium, which focuses on encouraging youngsters to gain not just greater understanding but an excitement for science. The facility, which operates under the rubric Planetarium Science Centre, offers state-of-the-art displays on astronomy and the earth sciences, and augments its permanent exhibits with summer workshops that introduce young people to a range of scientific fields that includes biology, environmental studies and physics. Each June, the library also holds a special event, 'On the Footsteps of Eratosthenes', during which children measure the Earth's circumference using of the methods that Eratosthenes first used more than 2,000 years ago. The library also sponsors a History of Science Museum for visitors of all ages. The museum celebrates the contribution that science has made to global well-being, paying particular attention to the often-neglected contributions that scientists from Egypt and the Arab region have made to this global effort. The second phase of the museum, which was created in collaboration with the French Ministry of Higher Education, examines scientific progress during the Renaissance and contemporary times. For still older but no less curious visitors, the library's new institute for ethics and science examines the ethical underpinnings that should inform and drive scientific research, encouraging scientists from throughout the Arab region to participate in the dialogue.* Bibliotheca Alexandrina *also hosted a series of activities related to the UN-sanctioned World Year of Physics 2005, highlighted by the Einstein Symposium, which was attended by three Nobel Laureates. Finally, since June 2005,* Bibliotheca Alexandrina *has been hosting the secretariat for the TWAS Arab Regional Office (ARO). The arrival of the regional office ensures a close relationship between* Bibliotheca Alexandrina *and TWAS in the years ahead.*

EACH YEAR, TWAS AWARDS MEDALS TO ACADEMY MEMBERS WHO ARE ACTIVELY ENGAGED IN GROUND-BREAKING RESEARCH. THE SCIENTISTS ARE INVITED TO PRESENT THEIR WORK AT THE ANNUAL TWAS GENERAL MEETING. SUMMARIES OF THE TWO 2005 TWAS MEDAL LECTURES, PRESENTED AT TWAS'S 16TH GENERAL MEETING IN ALEXANDRIA, EGYPT, LAST DECEMBER, FOLLOW.

TWAS MEDAL LECTURES

HOW DIFFERENT FROGS DEVELOP

According to Eugenia del Pino Veintimilla (TWAS Fellow 1989) of the Pontifical Catholic University of Ecuador, "Developmental biology is one of the most progressive areas of biological research today."

"To understand the mechanisms of embryonic development, scientists concentrate their efforts on certain 'model organisms' such as the African clawed frog, *Xenopus laevis*," she explained. "Indeed," she continued, "we probably know more about the embryonic development of *Xenopus* than we do of humans."

As with other frogs with aquatic reproduction, *Xenopus* spawn is laid in water. Abandoned by the parent frogs, the eggs are left to develop on their own into tadpoles and, eventually, young frogs. In tropical regions of the world, in particular, many frog species have developed other modes of reproduction that reduce or eliminate this aquatic larval period. Many such species are found in del Pino's home country, Ecuador.

Ecuador, on the northwest coast of South America, is one of the world's 17 megadiverse countries. Although it covers just 0.17 percent of the world's land area, it is home to more than 10 percent of terrestrial mammals. In addition, it is home to some 440 species of amphibians – three times as many per unit area as neighbouring Colombia and 20 times as many per unit area as Brazil. In addition, some 175 of these species are endemic to Ecuador, that is, they are found nowhere else in the world.

"This great diversity of amphibians, uniquely adapted to the diverse habitats found in Ecuador, demonstrates a wide variety of life-cycle adaptations and provides an ideal opportunity for novel

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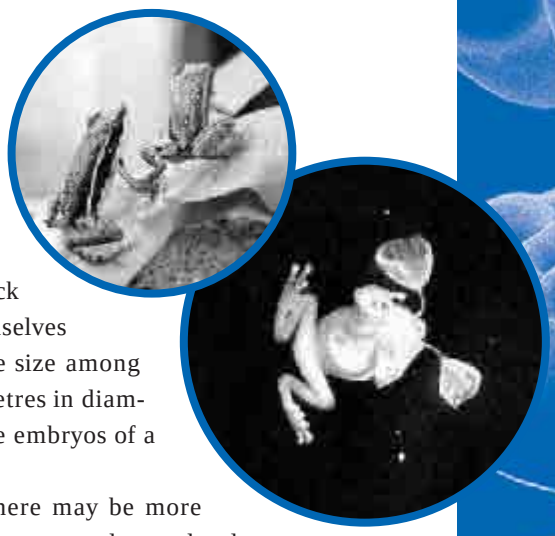


research, particularly in developmental biology," said del Pino.

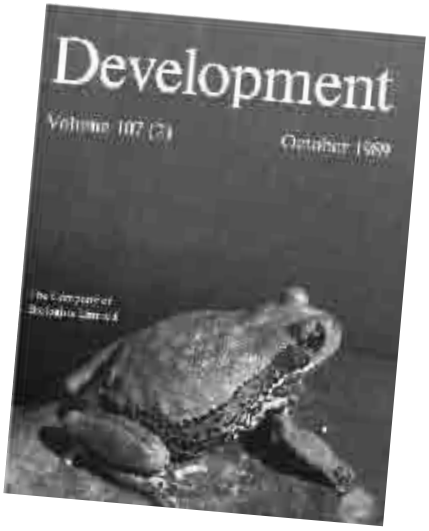
The marsupial frog, *Gastrotheca riobambae*, a frog that is endemic to Ecuador, displays parental care – the eggs and young tadpoles develop inside a pouch on the back of the mother frog instead of in the water. The eggs themselves are some three millimetres in diameter. This is a moderate size among marsupial frogs. In other species eggs can reach ten millimetres in diameter – the largest frog eggs known and similar in size to the embryos of a small bird.

Once inside the mother's pouch, the eggs, of which there may be more than 100, are incubated for about four months and develop to an advanced tadpole. In other *Gastrotheca* species, development in the pouch even goes as far as the juvenile frog stage. The parental care that these frogs offer has resulted in a retardation of the development process that has parallels with the slow development observed in mammals.

Similarities with mammalian reproduction extend to the hormonal control of embryonic incubation. In a series of elegant experiments, del Pino has demonstrated that increasing levels of the hormone progesterone induce the pouch to close and allow the incubation of the eggs. For example, the pouch forms chambers well supplied with blood vessels that envelop each embryo. In addition, the gills of the embryo become modified to form a sheet of tissue that surrounds each embryo to facilitate the exchange of water, oxygen, nutrients and waste materials with the mother's pouch. Again, this gill-pouch combination resembles the mammalian system consisting of the embryo's placenta and the mother's womb.

Reproductive differences between marsupial frogs and the *Xenopus* model are also associated with dramatic modifications of the embryonic programme of development. "In fact, not only do the embryos develop specialized gills," said del Pino, "but early development has been greatly modified."

Early embryological development in all species begins with cleavage, typified by a cluster of dividing cells. Even at this early stage, del Pino has found significant differences in the timing and morphology of the development of *Gastrotheca*. In a process known as gastrulation, part of the embryo surface becomes internalised and the three germ layers, the ectoderm, mesoderm and endoderm, acquire their identity, outlining the future body plan of the animal. In embryological terms, the tiny hole created by the ingression of cells to the interior during gastrulation is known as the blastopore and the new cavity that is thus formed is called the archenteron, or primitive gut.



"As a result of gastrulation," explained del Pino, "the embryos of *G. riobambae* form an embryonic disk of small cells around the blastopore. The body of the embryo itself derives from this disk. Although development from a disk of cells is characteristic of development in birds," continued del Pino, "this is the most divergent mode of gastrulation so far described for frogs."

Besides the marsupial frog, del Pino also studies the development of another frog endemic to Ecuador, the 17-millimetre long *Colostethus machalilla*. This frog also has a terrestrial life cycle. In this species, which reproduces frequently, only about 15 eggs are laid each time. The female deposits these in a 'nest' on a leaf or on the ground, which remains under the care of the father for about 20 days. At this point, the eggs hatch and the male frog transports them to a suitable pool. In this way, the early period of development is protected. As is the case with *Gastrotheca* – the development of *Colostethus* is delayed.

The current focus of del Pino's work is the careful dissection of the embryological development of these frog species. Using a range of techniques, from simple microscopic observation of complete embryos to sophisticated immune detection, sectioning and staining methods, del Pino and her group have described the stages of development in both *Gastrotheca* and *Colostethus* embryos, comparing and contrasting the timing of the appearance and duration of such embryonic structures as the blastopore, the archenteron and the notochord, a rod-shaped mass of cells that is thought to provide mechanical strength to the developing embryo.

Studies on *Xenopus*, for example, have revealed that the expansion of the archenteron typically occurs during gastrulation. In contrast, del Pino has shown that, in the two Ecuadorian frogs she has studied, the expansion of the archenteron occurs much later. In addition, the notocord elongates during gastrulation in *Xenopus*, but not until after gastrulation, once the blastopore has closed, in *Gastrotheca* and *Colostethus*. Although *Colostethus* does not form an embryonic disk, it does form thick blastopore lips that resemble the embryonic disk of *Gastrotheca*.

"This represents an important deviation from the gastrulation pattern observed in *Xenopus*," observed del Pino. "Curiously," she added, "some genetically deficient *Xenopus* embryos have been shown to resemble the gastrulation variations we have discovered in nature."

"These studies show not only what an excellent model *Xenopus* has been for embryological studies, but also that, owing to their different developmental strategies, the two Ecuadorian frogs can also be useful model species," concluded del Pino. "In addition, these studies have not only contributed to the advancement of science, but have also provided the means for training many students and other young researchers in many biological techniques in Ecuador."

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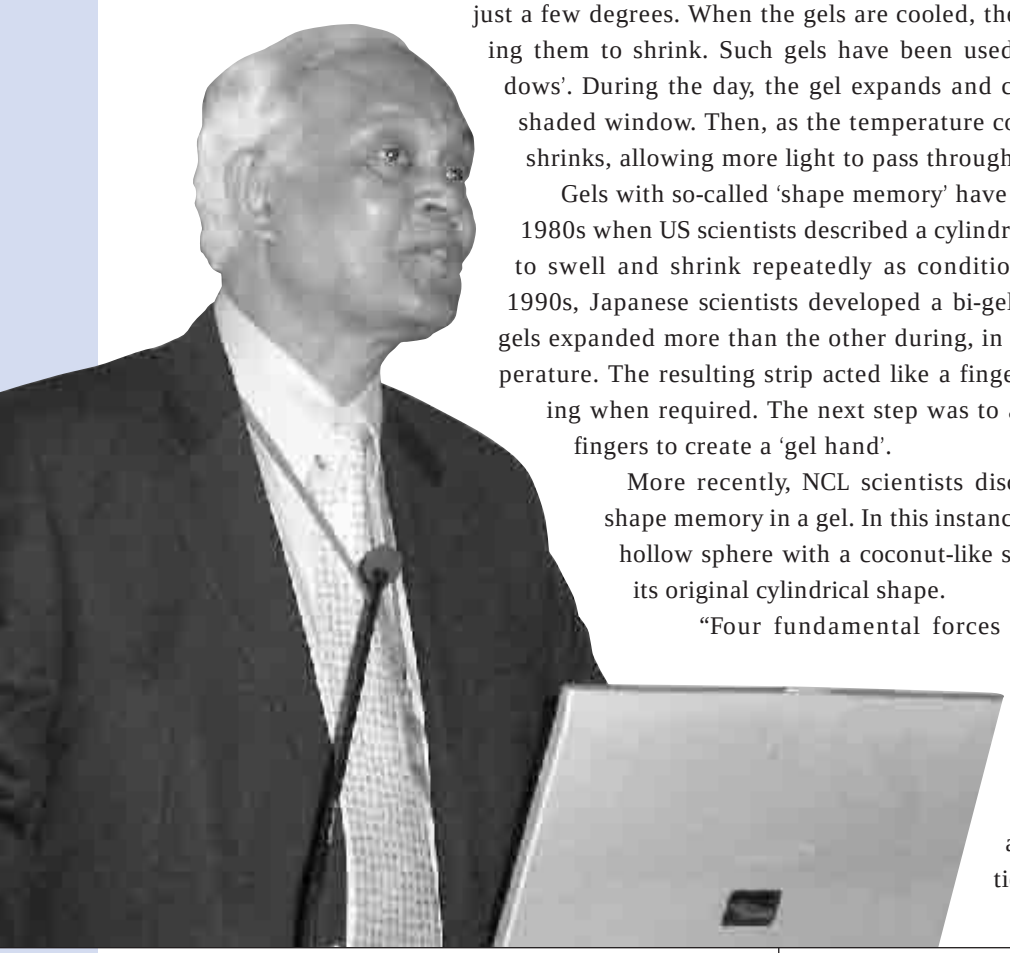
PUTTING LIFE INTO GELS

Gels, or cross-linked matrices of macromolecules, are becoming increasingly sophisticated, and scientists and technologists around the world are using such gels in many novel applications. The race is on, however, to produce yet more sophisticated gels with a variety of useful properties.

"In the 1970s we spoke of developing hardware and software," explained R.A. Mashelkar, director general of India's Council of Scientific and Industrial Research (CSIR). "Now we are talking about wetware. Gels, which are now used widely as absorbants, for example in sanitary napkins, or as support structures in tissue culture, could be used to make artificial muscles, optical shutters, sensors and other items."

Mashelkar then described some recent discoveries and developments at the National Chemical Laboratories (NCL), Pune, India, and other institutions.

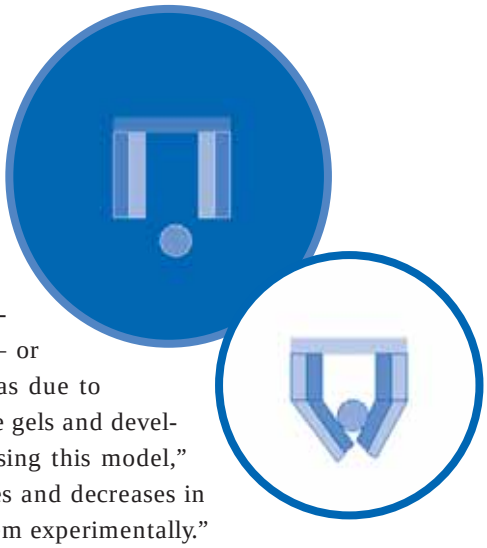
For example, there are gels that can increase their volume ten-fold when they are heated by just a few degrees. When the gels are cooled, the process is reversed, causing them to shrink. Such gels have been used to make 'intelligent windows'. During the day, the gel expands and clouds out light, creating a shaded window. Then, as the temperature cools in the evening, the gel shrinks, allowing more light to pass through.



Gels with so-called 'shape memory' have also been known since the 1980s when US scientists described a cylindrical gel that could be made to swell and shrink repeatedly as conditions changed. Then, in the 1990s, Japanese scientists developed a bi-gel strip in which one of the gels expanded more than the other during, in this case, a change in temperature. The resulting strip acted like a finger, bending and straightening when required. The next step was to align two or three of these fingers to create a 'gel hand'.

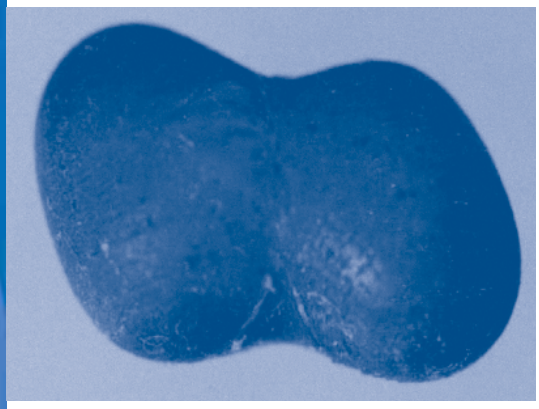
More recently, NCL scientists discovered a unique form of shape memory in a gel. In this instance, a cylinder converted to a hollow sphere with a coconut-like structure and back again to its original cylindrical shape.

"Four fundamental forces control the behaviour of most responsive gels," explained Mashelkar. "These are hydrogen bonding, van der Waals force, ionic interactions and hydrophobic interactions."



Mashelkar then described how the Flory theory of swollen networks (gels typically contain water or another solvent among their cross-linked chains), which takes into account the original volume of the gel and the number of cross-linkages, did not apply to a specific type of gel being investigated at NCL, so-called lower critical solution temperature – or LCST-type gels. Mashelkar and his team reasoned that this was due to the presence of a large number of hydrogen bonds in LCST-type gels and developed a new theoretical model that took this into account. "Using this model," explained Mashelkar, "we can predict changes such as increases and decreases in volume caused by pH or temperature changes and then test them experimentally."

As one example, Mashelkar cited the zipping and unzipping effect in poly(*N*-isopropylacrylamide) (PNIPA) gels. As the temperature increases, the model predicts that the number of hydrogen bonds between the polymer and water will decrease while those between the gel polymers will increase.



"We tested this in the lab and found that the results closely followed our predictions," added Mashelkar. "In addition, by altering the co-monomer – the hydrophobic part of the gel-forming molecule – we were also able to control the temperature at which the zipping and unzipping occurred." Such gels are already finding uses as inserts to make shoes more comfortable as the temperature of the foot varies.

The NCL scientists' new model was also able to explain how a gel cylinder could turn itself into a hollow sphere and back again under certain conditions. When placed into a solution of copper chloride, the cylinder swells and allows cupric ions to enter and bind to carboxyl groups on the chains of the gel molecules. This creates molecules tightly bound to copper on the outer surface of the gel. The stresses caused by these strong complexes are enough to break covalent bonds within the cylinder. Since the hydrophilic carboxyl groups at the surface are bound in a copper complex, the surface effectively becomes hydrophobic in water. The gel cylinder, therefore, tries to minimize its surface energy – which it achieves by becoming spherical. The whole process can be reversed by placing the now hollow sphere in hydrochloric acid – and repeated over and over again.

One potential application for such a system, explained Mashelkar, could be to allow a gel cylinder to absorb such useful biomolecules as haemoglobin, becoming spherical in the process,

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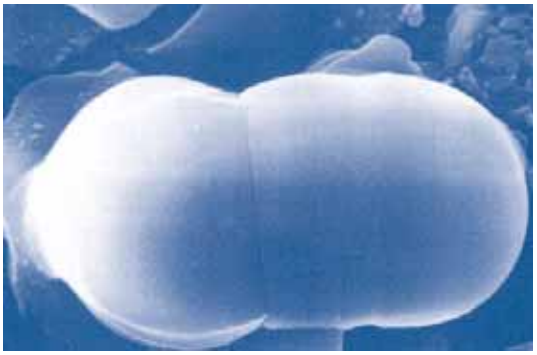

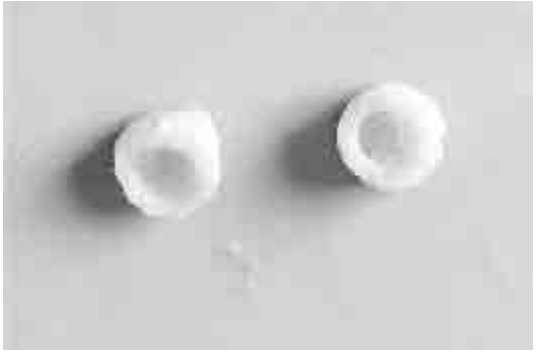

and to release the biomolecule slowly as they are put in an acidic environment, such as that found in the stomach. It has also been demonstrated that the rate of release of useful molecules from such systems is constant over time.

The discovery of the sphere-forming cylinder was serendipitous and Mashelkar freely admitted that another ground-breaking area of research – that of self-healing gels – also had a fortuitous beginning.

"For theoretical reasons, two gels could not be welded together because each one represents a giant macromolecule," said Mashelkar. "However, a chance scanning electron microscope picture seemed to show two macromolecules apparently welded together."

Additional experiments have confirmed that this was the case and, again, strong forces owing to the binding of cupric ions are involved. This chance observation, followed by painstaking research, has opened a new way of creating metal ion-induced healing in gels.

"We have analysed the deformation dynamics in experimental systems but we are still working on many unanswered questions," added Mashelkar, who advised that all experimental results, even those that are considered failures, should be followed up.

Mashelkar and his team have also had success in developing 'gelzymes', artificial versions of enzymes – the catalytic driving forces behind all living organisms. Gels containing different components of the active sites of the protein-digesting chymotrypsin enzyme, for example, have been synthesized. This was achieved by the polymerization of a supramolecular structure comprising the complex formed by monomers bearing the respective functional groups of the enzyme and the template in the presence of a cross-linking molecule. By using such agents as ultraviolet light or changes in pH, such gelzymes could be made to switch their activity on and off. "We have shown that such enzyme mimics are still functional even after 50 switching cycles," he said.

Mashelkar began his lecture by introducing the sea slug – a simple organism with a gel-like body that can feed itself, heal itself, respond to predators and reproduce. While 'putting life into gels' is still a distant dream, with the development of gels with shape memory, moving fingers, the ability to self-heal and gelzymes, Mashelkar claimed that researchers had "put a little more life into gels". In future, the development of new gel-forming molecules and further advances in polymer science could be combined to create life-like systems that are able to behave like the sea slug. For many, that would be a sobering thought. For Mashelkar and his colleagues, it is exhilarating. ■

SOIL, SUGAR AND CARBON SINKS

ADOLPHO JOSE MELFI, PROFESSOR OF GEOLOGY AT THE UNIVERSITY OF SAO PAOLO, BRAZIL, WAS ONE OF EIGHT DEVELOPING WORLD SCIENTISTS PRESENTED WITH A 2004 TWAS PRIZE BY PRESIDENT MUBARAK DURING THE TWAS 16TH GENERAL MEETING IN EGYPT. HIS PRIZE LECTURE EXAMINED THE LINKS BETWEEN SOILS, AGRICULTURE AND GLOBAL CLIMATE CHANGE.

Adolpho José Melfi, who currently serves as rector of São Paolo University, Brazil, earned his scientific reputation by studying geochemistry, rock alteration and the formation of tropical soils. He then applied this expert knowledge to agricultural and environmental problems. His current studies – the focus of his TWAS Prize lecture – involve analysing the impact of agricultural practices on Brazilian soils and the carbon cycle – critical factors in the understanding of perhaps the most important environmental issue facing the world today – global climate change.

"The concept of global warming is linked to the emission of such greenhouse gases as carbon dioxide, methane and oxides of nitrogen," explains Melfi. "These gases are mainly produced by human activities related to the use of fossil fuels."

Although the Kyoto Protocol, which calls for caps in carbon emissions, came into effect in February 2005, analysts predict that the use of coal, oil and natural gas will continue to increase over the foreseeable future. Indeed, the world's best climate models anticipate that, by the end of this century, the average increase in surface temperatures around the world will be between 1.5 to 5.5 degrees Celsius higher than their average values recorded over the past few decades.

SOURCES AND EMISSIONS

"An analysis of global carbon emissions," says Melfi, "reveals that the burning of fossil fuels is responsible

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for about two-thirds of the total, with agricultural activities and land use changes contributing to a significant one-third. However, when considering only developed countries, the contribution from burning fossil fuels is much higher. This means that, in developing countries, the contribution from agriculture and land use changes is more than one-third."

Indeed, when considering Brazil, greenhouse gas emissions from industrial sources represent just 25 percent of the country's emissions, compared to around 75 percent in most developed countries. Thus Brazil is ranked 17th in the world in industrial greenhouse gas emissions. However, when taking into account agricultural practices and land use changes, which account for 75 percent of Brazil's emissions, the country leaps up the emissions rankings to the fifth place.

"So far, the importance of different agricultural practices and changing land use patterns on the carbon cycle in developing countries is an area that has received little attention," adds Melfi.

The proportions of the different greenhouse gases produced by agriculture also differ from those produced by industry, explains Melfi. Whereas carbon dioxide from industrial sources accounts for some 66 percent of the total greenhouse gas emissions, together, agriculture and land use change account for some 55 percent of the methane produced, 80 percent of the oxides of nitrogen and 22 percent of the carbon dioxide. Because of emissions from rice cultivation and animal production, methane is the principal greenhouse gas produced from agriculture. In tropical areas, the change in land use from previously forested areas to agricultural production, typically brought about either by burning or logging, also represents a significant contribution to global warming. Slashing and burning one hectare of a tropical forest, for example, transfers some 100 to 200 tonnes of carbon, previously located in the above-ground biomass of the forest, to the atmosphere.

"Thus, rational land use, through practices adapted to tropical regions, could be a safe and more effective way of minimizing the effect of greenhouse gas emissions in the atmosphere and, at the same time, increase the sequestration of these gases by soils and vegetation," concludes Melfi.

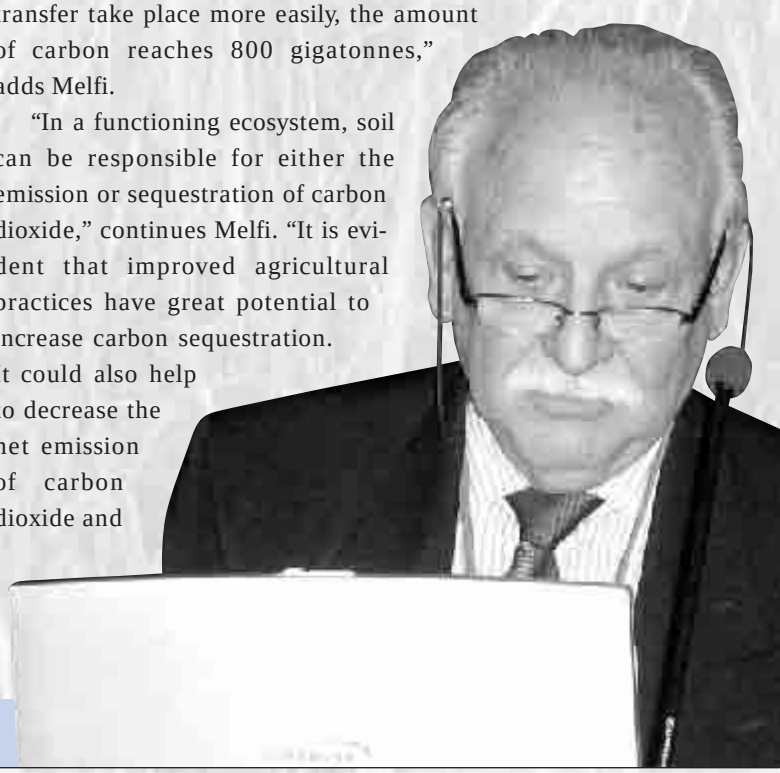
Rational land use could be a safe and more effective way of minimizing the effect of greenhouse gas emissions.

IMPORTANCE OF SOIL

"A soil profile," explains Melfi, "consists of layers that have developed over time, each with its own characteristic composition. A soil's upper layers tend to be rich in organic matter while deeper layers are mainly mineral." Indeed, although soil contains just five percent organic matter (mineral matter accounts for 45 percent, with air and water – important components of the soil pores – making up the remaining 50 percent), soil is the largest carbon reservoir on the surface of the Earth. For example, the world's soils hold between 1,500 and 2,000 gigatonnes of carbon. That compares to an estimated 730 gigatonnes in the atmosphere and between 470 to 655 gigatonnes in all the world's vegetation.

"Even taking into consideration just the top 30 centimetres of soil, where processes of organic matter transfer take place more easily, the amount of carbon reaches 800 gigatonnes," adds Melfi.

"In a functioning ecosystem, soil can be responsible for either the emission or sequestration of carbon dioxide," continues Melfi. "It is evident that improved agricultural practices have great potential to increase carbon sequestration. It could also help to decrease the net emission of carbon dioxide and



other greenhouse gases. But policy makers have not widely recognized this potential," he adds.

"There are several agricultural practices that can mitigate or even eliminate greenhouse gas emissions to the atmosphere," claims Melfi. Three of these currently being practiced in Brazil are:

- a no-tillage system;
- the application of sewage sludge; and
- the sugar cane system.

No-tillage system. In conventional agriculture, a large amount of fossil energy fuels the tractors that plough the fields. In addition, straw is usually baled up and carted away or, in some cases, burned off. Using the no-tillage system, the soil is only moved slightly and the straw is left as a residue that decomposes, helping to increase the amount of carbon in the soil and releasing less carbon dioxide into the atmosphere. The potential for carbon sequestration in semi-arid regions is calculated to be 0.05 to 0.2 tonnes of carbon per hectare per year, and in tropical regions to be 0.2 to 0.4 tonnes of carbon per hectare per year. Estimates for Brazil, taking into account the top 10 centimetres of soil, are between 0.5 and 0.7 tonnes of carbon per hectare per year.

"Based on the figure of 0.5 tonnes of carbon per hectare per year and the utilization of the no-tillage system in Brazil, which is currently practiced on 20 million hectares, the reduction of carbon emissions to the atmosphere is some 10 million tonnes. In addition, 0.3 million tonnes of carbon is 'saved' by not using heavy agricultural machinery," says Melfi. "Although conventional agriculture replaces part of the carbon lost by deforestation through soil sequestration, by using the no-tillage system it is possible to recover the carbon stock in the soil."

Sewage sludge application. Globally, human population is increasing, a trend that brings many environmental problems, among which is the question of disposing

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of human waste. In much of the developed world, water treatment facilities are used to clean and recycle sewage-laden water. Elsewhere, untreated sewage often pours into rivers or is dumped at sea. Another option, though, is to stabilize the 'waste' by composting, heat drying or chemical fixation, turning it into what is politely called 'biosolids', or, more commonly, sewage sludge.

The application of sewage sludge is widely used in many countries, but is only now being studied in Brazil.

"Because sewage sludge contains a rich supply of nutrients, including carbon, nitrogen, phosphate and magnesium," says Melfi, "it can be spread on farmland, in forests or used for public works projects, landscaping activities or for land reclamation."

According to Melfi, sewage sludge can also be used to improve degraded tropical soils and, by promoting the growth of plants, to enhance the sequestration of additional carbon from the atmosphere.

Sugar cane system. "Brazil's sugar cane plantations offer two ways to mitigate the emission of carbon into the atmosphere," says Melfi.

Traditionally, sugar cane is harvested by hand. To facilitate this, it is necessary to burn the crop, a process that removes the unwanted foliage but leaves the sugar-containing cane in place and makes it easier to handle. The introduction of mechanical harvesting has meant that the leaves are no longer burned, thus reducing carbon dioxide emissions. They are, however, left on the ground where they decompose and add carbon to the soil.

Mechanical harvesting, however, requires crops of sugar cane to be grown in fields with less than a 15 percent slope. Currently, it is being practiced on 20 percent of the sugar crop in Brazil, or some 1.5 million hectares, but the potential is there for this to be increased to 50 percent.

"By changing harvesting practices, carbon sequestration could reach 2.7 to 3.5 million tonnes of carbon per year," says Melfi.

ALTERNATIVE FUELS

The Brazilian sugar industry also has a long history of providing the country with alternative 'biofuels'. "The use of alcohol produced from sugar cane as a fuel in vehicles emits less carbon dioxide to the atmosphere because its combustion is cleaner compared to gasoline," says Melfi. "In addition, as part of this carbon

dioxide is subsequently used by plants in photosynthesis, this closes the carbon cycle."

Between 1975 and 2000, Brazil produced some 227 million cubic metres of alcohol from sugar. During this 25-year period, substituting this alcohol for fossil fuels resulted in 173 million tonnes of carbon not being introduced into the atmosphere. "In other words," explains Melfi, "the emission of 173 million tonnes of carbon was avoided."

"The environmental gain from Brazil's alcohol production is even higher," adds Melfi, "as Brazil exports alcohol to several countries, including Japan, which now adds 3 percent alcohol to its fuel."

In addition, carbon emissions can also be offset by burning a by-product of sugar production, bagasse – the fibrous fraction of the sugar cane plant from which all the economically recoverable sugar has been extracted. In the late 1980s, bagasse use in Brazil was at a low of about 20 million tonnes a year. Its present rate of use, some 45 million tonnes a year, results in an offset of carbon emissions in the region of 8 million tonnes.

"Thus, when taking into account the substitution of fossils fuels with alcohol, the burning of bagasse and mechanical harvesting, Brazil's sugar industry, reduces emissions by a total of 21 million tonnes of carbon a year," concludes Melfi.

Brazil's sugar industry reduces emissions by a total of 21 million tonnes of carbon a year.

IMPLICATIONS

Current land use and agricultural practices are responsible for emitting large amounts of carbon dioxide and other greenhouse gases into the atmosphere and for incorporating small amounts of carbon into the soil. "A shift to more environmentally-friendly practices is possible through the adoption of appropriate technologies such as conservation tillage, not burning sugar cane and the application of biosolids to agricultural land," says Melfi.

Under the Kyoto Protocol, there is also an incentive for policy makers to adopt and promote such practices. In the so-called 'carbon market', one carbon credit (1 CER) is equivalent to one tonne of carbon dioxide that was not released into the atmosphere or was sequestered into the soil. At current global market prices, 1 CER can be traded for between US$3 and US$5.

"In other words, the 21 million tonnes of carbon emissions offset by Brazil's sugar industry each year, equivalent to some 77 million tonnes of carbon dioxide, could be worth between US$231 and US$385 million," concludes Melfi.

Even discounting the other invaluable environmental services provided by soils, figures such as these demonstrate the importance of soil as a valuable natural resource – equally as important to human and environmental well-being as clean air, clean water and the Earth's biodiversity.

"Soil is a resource that we need to do more to protect," adds Melfi. "It is time decision makers understood its vital role in natural processes and encouraged practices that promote its conservation and use as a carbon sink." ■

IN THE AFTERMATH OF A MEGA-TSUNAMI

EVER SINCE A MEGA-TSUNAMI OF UNPRECEDENTED DEADLY FORCE STRUCK THE COAST SURROUNDING THE INDIAN OCEAN IN DECEMBER 2004, GOVERNMENTS THROUGHOUT THE REGION HAVE SOUGHT TO THWART THE IMPACT OF THE NEXT EARTHQUAKE-DRIVEN TIDAL WAVE BY DEVELOPING EFFECTIVE TSUNAMI DETECTION AND WARNING SYSTEMS. HARSH GUPTA, HEAD OF INDIA'S DEPARTMENT OF OCEAN DEVELOPMENT, EXPLAINS THE STEPS THAT HIS NATION HAS TAKEN AND PLANS TO TAKE IN THE YEARS AHEAD.

A languid morning marked by brilliant sunshine and calm seas made the holiday season in southeast Asia that much more special.
The day after Christmas had begun innocently enough both for those who lived there and for those on vacation.

But events would soon turn 26 December 2004 into a day the world would never forget. At 6:58 local time, a mega-tsunami, triggered by the second largest earthquake ever recorded (measuring 9.3 in magnitude and caused by a rupture along a fault 1,300 kilometres in length), began its silent, super-swift journey in the northern Indian Ocean some 160 kilometres west of the island of Sumatra in Indonesia.

While travelling in the deep ocean, the tsunami never caused surface waters to rise more than 30 centimetres. But as it approached the shoreline, tsunami-induced wave crests reportedly reached heights of 30 metres, unleashing repetitive bursts of water and energy that swept away everything – and everyone – in their path.

Some 40 minutes after the seabed earthquake, the tsunami barrelled into Banda Aceh, the capital city of Indonesia's Aceh province, claiming 168,000 victims. An hour later, it swept into Phuket and the nearby fishing villages and coastal resorts of Thailand, killing

Harsh Kumar Gupta

more than 5,500 people. But the tsunami's journey had just begun. A relentless wall of water, it sped across the Bay of Bengal, slamming into the coast of India, where it took 15,000 lives, and Sri Lanka, where it claimed another 30,000 people. The majority of its victims were women and children unable to reach higher ground.

Leaving Asia behind while travelling at the speed of a jet aeroplane – some 500 to 1,000 kilometres per hour (the seismic waves of an earthquake, in contrast, travel at speeds of 5 kilometres per hour) – the tsunami would continue its path of death and destruction, sweeping across the western Indian Ocean, eventually battering the coast of east Africa. Some 300 people fell victim to the tsunami in Somalia. Causalities were also reported in Kenya, Tanzania and Yemen. The tsunami finally gave out near Port Elizabeth, South Africa, some 8,000 kilometres from where it began.

All told, more than 220,000 people in 11 countries were killed and another 1.5 million were left homeless in one of the worst natural disasters in human history.

IN INDIA

Along the coast of India, the height of the tsunami's wave crest reached an estimated 4.5 metres at Port Blair, 3.2 metres in Chennai and 1.5 in Cochin.

While the Indian coast is certainly at risk from tsunamis – especially in coastal areas along the Java-Sumatra volcanic belt in the Bay of Bengal or near the fault lines in the Arabian Sea – historically such events have been extremely rare. Experts estimate that 85 percent of all tsunamis have occurred in the Pacific Ocean and that most others have taken place in the Mediterranean and Caribbean seas. Indeed, assessments of the historic records, dating back to 326 BCE, indicate that the Indian Ocean has experienced just six mega-tsunamis over the past 2,500 years.

The most complex risk management challenges are often posed by extremely rare events that prove extremely deadly when they strike.

The rarity of a tsunami event, however, does not deny the potential devastation that accompanies its arrival. On the contrary, the scarcity of such events makes it even more difficult to develop effective warning systems. The most complex risk management challenges, in fact, are often posed by extremely rare events that prove extremely deadly when they strike. Remaining vigilant over long periods of time is not easy to do – regardless of the size of the threat.

[CONTINUED PAGE 42]

Nevertheless, the basic elements of an effective tsunami detection and warning system are well known among scientists who have studied these devastating events. The key to success is to put in place mechanisms that are capable of detecting a tsunami in real time and then conveying that information quickly to both public officials and the public at large.

This overall strategy requires ocean bottom sensors like those, for example, that have been successfully deployed by a consortium of Pacific rim countries to spot the more frequently occurring tsunamis that take place in that region. It means calculating the travel time from potential sea-bottom tsunami locations to populous coastal areas. It means preparing inundation maps based on modelling and careful assessments of historical documents. And it requires devising effective communication schemes that convey the information as swiftly as possible to those most at risk and then providing evacuation plans to help ensure their safety.

The basic elements of an effective tsunami detection and warning system are well known.

DUAL USE

Comprehensive surveillance systems, such as the one described above, should be designed not only for tsunamis but also for storm surges. Such 'dual-use' detection and warning systems make it easier to justify their costs and, at the same, help the public remain aware of the warning system once it is in place. In India, this strategy could prove particularly useful because more than 10 percent of the world's cyclones take place in the northern Indian Ocean, most notably in the Bay of Bengal, which has experienced nearly 60 cyclones over the past 35 years alone.

The plan that the Indian government has developed in the aftermath of the December 2004 mega-tsunami calls for:

- Upgrading and connecting existing seismic stations, which will more than triple in number from 51 to 170.
- Establishing a network of eight to 10 bottom pressure recorders in potential areas of tsunami activity in the northern Indian Ocean.
- Installing a chain of 45 to 50 sea level monitoring stations at critical points on the mainland, on islands and on off-shore platforms.
- Building 10 radar-based monitoring stations for real-time measurement of surface currents and waves.

- Devising more sophisticated models for projecting the behaviour and intensity of tsunamis and storm surges.
- Generating detailed coastal inundation and vulnerability maps based on existing data and models.
- Developing more effective educational and training programmes both for experts and the public on matters related to tsunamis and storm surges.

This initiative, which was launched in February 2005, will cost an estimated US$30 million. The Department of Ocean Development will lead the effort, which will also enjoy the active involvement of India's Department of Science and Technology, Department of Space and Council of Scientific and Industrial Research (CSIR). India's universities and research institutes will also participate.

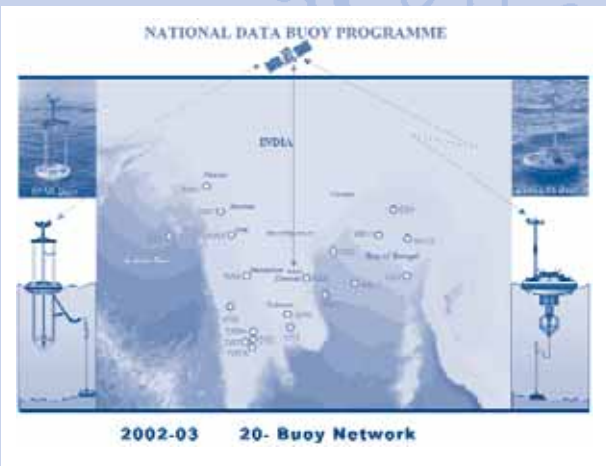
India is expected to have a comprehensive warning system in place by September 2007. The goal is to reduce the average time that it takes to inform the public of the occurrence of a tsunami or storm surge from 40 minutes to 10 minutes.

Thirty minutes may not seem like much. But this saving in time could ultimately save thousands of lives. And as the events of 26 December 2004 tell us, in dark and deadly ways, time does indeed matter. ■

Harsh Kumar Gupta *(TWAS Fellow 1995)*
Secretary
Department of Ocean Development
New Delhi, India
email:
dodsec@dod.delhi.nic.in

INDIA IS NOT ALONE

India is not the only nation in southeast Asia that has begun to build a detection and early warning system to safeguard citizens against the potential deadly impact of tsunamis and storm surges. Indonesia, for example, plans to develop a warning network that includes sea floor sensors and associated buoys as well as coastal sirens and sound systems. Thailand has decided to install 62 warning towers and to put in place a National Disaster Warning Centre, which received its first test on 4 July 2005 when a 7.3-magnitude earthquake struck the Nicobar Islands, about 660 kilometres west of the mainland. Warnings were issued following the ocean floor earthquake but, fortunately, the quake failed to produce a tsunami. Malaysia, the Maldives and Sri Lanka have also launched comprehensive detection and warning programmes.

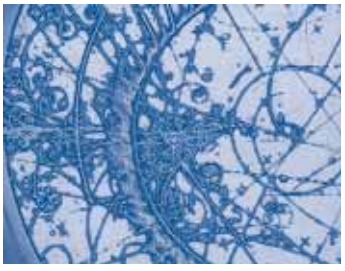


Meanwhile, other regions of the world have also taken note of the Indian Ocean mega-tsunami to improve their own warning and detection systems. For example, the Pacific Tsunami Warning Center, located in Hawaii and operated by the US National Oceanic and Atmospheric Administration (NOAA), will add 32 additional DART (deep-ocean assessment and reporting of tsunamis) buoys to what is the world's most sophisticated detection and warning system. In addition, the Intergovernmental Oceanographic Commission, which operates under the auspices of the United Nations Educational, Cultural and Scientific Organization (UNESCO), plans to coordinate the Indian Ocean Tsunami Warning and Mitigation System. The initiative, which will cost an estimated US$200 million, is expected to become operational in the next few years.

TWAS CELEBRATES EINSTEIN'S MIRACULOUS YEAR

IN THE WORLD OF PHYSICS, EINSTEIN'S SUCCESSES ARE INDEED WORTH CELEBRATING. BUT SO ARE HIS SHORTCOMINGS.

The World Year of Physics 2005, a UN-sponsored celebration of the centennial anniversary of Albert Einstein's annus mirabilis *(miraculous year), was characterized by countless exhibitions, symposia, workshops and lectures around the world.*



The initiatives, which took place in libraries, museums, research centres and universities, were designed to explore the impact of physics on our global society and to generate greater awareness and enthusiasm for a field of science often disregarded – or should we say discarded – by the public as "too hard to understand" and "too removed from everyday life to make a difference".

To help counter this public perception, a pair of widely publicised 'bookend' events marked the beginning and conclusion of this year-long celebration: an inaugural conference that took place in Paris in January 2005 and a closing conference that took place in November 2005 in Durban, South Africa. Both events were sponsored by the United Nations Educational, Cultural and Scientific Organization (UNESCO), and a number of other scientific institutions, including the Abdus Salam International Centre for Theoretical Physics (ICTP). The ICTP shares both a common heritage with TWAS (both institutions were created by the Nobel Laureate Abdus Salam) and a common site (the ICTP generously hosts the Academy's secretariat on its campus in Trieste, Italy).

The World Year of Physics 2005 marked the 100th anniversary of the most remarkable year in Albert Einstein's remarkable career. Indeed it marked one of the most noteworthy years in the history of modern science, rivalling Isaac Newton's 18-month *annus mirabilis* in 1665-1666 during which time he invented calculus, uncovered how gravity works and explained the laws of motion.

In 1905, Einstein experienced a similar burst of genius highlighted by the publication of four illustrious papers in *Annalen der Physik*, Germany's pre-eminent physics journal.

Each paper in its own right represented a breakthrough in our understanding of physics. Together, the papers exerted a profound impact not only on the world of science but on society as a whole by greatly enhancing our understanding of how the world of atoms and molecules behave and by altering our very perception of how we see ourselves in the universe.

In these papers, Einstein, then just 26 years old and with a newly minted doctorate degree from the University of Zurich, proved that light consists of discrete particles (photons), a finding for which he won the Nobel Prize in 1921; described in detail a powerful new theoretical tool (Brownian motion) for detecting the random movement of atoms and molecules in gases and liquids; and explained his theory of special relativity, which established the relationship between mass and energy and between space and time (for which Einstein is best known). "A storm broke loose in my mind," Einstein would later note when asked about this stunning year of accomplishment virtually unmatched in the annals of science.

The World Year of Physics 2005 marked the 100th anniversary of the most remarkable year in Albert Einstein's remarkable career.

TWAS celebrated the World Year of Physics 2005 by holding a conference session at the TWAS 16th General Meeting in Alexandria, Egypt. The session, which was organized by Luiz Davidovich, professor of physics at the Federal University of Rio de Janeiro, Brazil, sought to commemorate Einstein's miraculous year by examining his impact both on science and society.

While honouring the past, the presenters also kept a keen eye on the future. Indeed one of the reasons that Einstein's accomplishments remain so compelling a century after they took place is that his findings have

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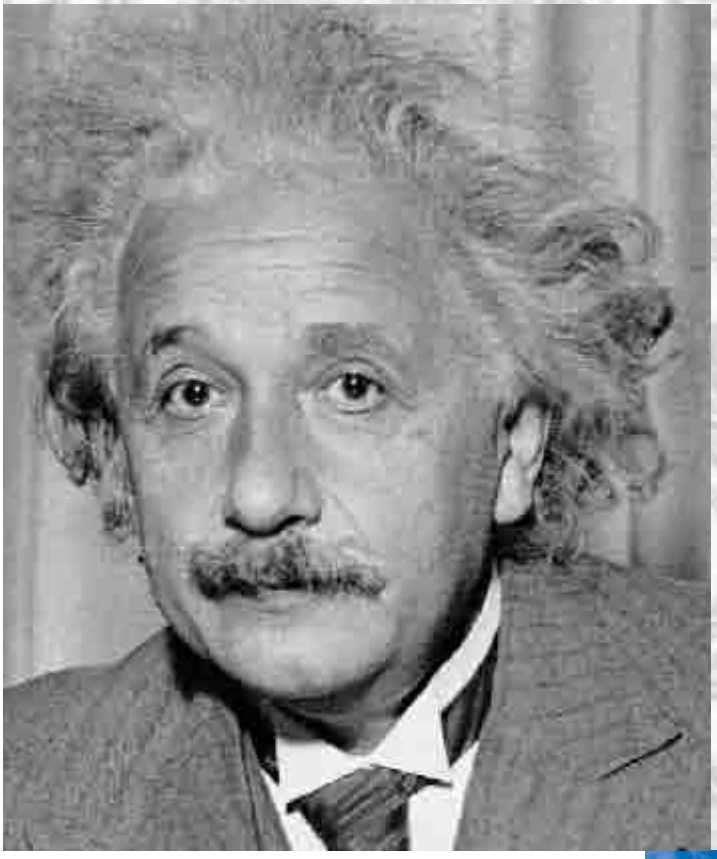
dramatically shaped physics throughout the 20th century and continue to influence the field to this day with implications that affect our society, our economy and even our ethical values.

Nobel Laureate Claude Cohen-Tannoudji (Physics 1997) gave the session's opening presentation, 'Light and Matter: The Modernity of Einstein's Ideas'. Cohen-Tannoudji, professor of physics at *École Normale Supérieure*, Paris, France, shared the Nobel Prize with Stephen Chu and William Phillips for developing techniques that utilize laser light to cool atoms to extremely low temperatures. In his presentation, Cohen-Tannoudji examined how Einstein's breakthrough discovery, which showed that light consists of photons (or wave-like particles), set the stage for the numerous applications of laser light that have taken place in the late 20th and early 21st centuries.

Govind Swarup, professor emeritus at the Tata Institute of Fundamental Research (TIFR) National Centre for Radio Astrophysics in Pune, India, gave a presentation on 'Cosmology and Astrophysics: From Einstein to Now'. Swarup's talk focused on Einstein's seminal contributions to our understanding of the early universe and its evolution ever since. Swarup, who is a fellow of the Royal Society of London and the Indian National Science Academy (INSA), gained international fame for his role in the building of India's radio telescope system, which seeks to explore the far reaches of the universe where the universe's first particles are thought to be located.

Lu Yongxiang, president of the Chinese Academy of Science (CAS), then provided a broad overview of physics over the past century – a century dominated by Einstein. Titled 'The Inspiring History of Physics in the Last 100 years: Retrospect and Prospect', Lu described



how physics, far from being removed from everyday life, has provided the foundation for many of the most seminal technological breakthroughs of the past century, ranging from the awesome power of the atom in the 1940s and 1950s to the stunning development of computers and the internet in the 1980s and 1990s. Lu, who also serves as vice president of TWAS, forecasts that physics will continue to play a vital role in such frontier fields as biotechnology (through, for example, biophysics and bioinformatics) and nanotechnology, which draws a great deal of its intellectual strength from our understanding of new materials and the structure of atoms and molecules.

Davidovich, who moderated the conference session, also gave a lecture during the session, entitled 'Spooky Action at a Distance: Exploring the Subtleties of Quantum Mechanics'.

His talk concentrated on quantum physics, one of the two pillars of theoretical physics; the other pillar is Einstein's theory of relativity. Specifically, Davidovich provided an overview of the international physics com-

munity's intense discussions following the discovery of quantum mechanics in the early 20th century, some twenty years after Einstein's miraculous year.

His presentation began with the formulation of Werner Heisenberg's uncertainty principle in the late 1920s. Davidovich then outlined a step-by-step 'quantum journey' that included a discussion of the Niels Bohr–Einstein debates, focusing on quantum mechanic's counterintuitive notion that "when you measure something you unavoidably change it by producing a change in the state of the system" (a notion that Einstein rejected); Erwin Schrödinger's breakthrough analyses of wave equations and quantum mechanics in the 1920s and 1930s; and John Bell's Einstein-defying findings on quantum theory and 'hidden' variables in the 1960s (Einstein insisted that there must be hidden variables; Bell found none). In conclusion, Davidovich discussed current efforts to apply quantum theory to such exotic fields as quantum computation and quantum cryptography.

Einstein remained the world's most respected – and vocal – proponent of the 'certainty' and 'deterministic' principles.

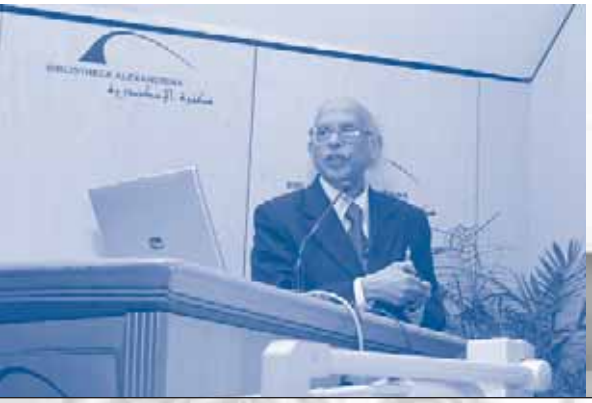
As Davidovich noted, his choice of examining Einstein's contributions to quantum mechanics may seem odd, especially to his colleagues in the field. After all, Heisenberg, not Einstein, is credited to have discovered quantum physics. Indeed Einstein was a persistent sceptic of the uncertainty principle, often dismissing it as an 'incomplete theory' of lesser value, or should we say of lesser certainty, than the theory of relativity.

So why did Davidovich choose to highlight Einstein's contributions to quantum physics, about which Einstein himself had expressed deep doubts? How does such a discussion fit into a series of celebratory presentations designed to honour the 100th anniversary of Einstein's incomparable contributions to modern physics?

In Davidovich's words, such an approach sheds even brighter light on Einstein's genius because it shows how his doubts and criticisms – and not just his assertions and theories – helped to shape the broad contours of physics over the past 100 years.

The uncertainty theory, as articulated by Heisenberg, claimed that the position and momentum (the product of mass and velocity) of such sub-atomic particles as electrons cannot be measured with absolute precision simultaneousy. That's because, as Heseinberg reasoned, the effort of measuring their position inevitably changes the momentum of the particles involved. In the words of Bohr, Heisenberg's mentor, the uncertainty principle is based on the notion that "we cannot at the same time know where a particle is and where it will go."

Einstein remained boggled by this 'probabilistic' assertion and was not bashful to say so. He preferred instead to remain the world's most respected – and vocal – proponent of the 'certainty' and 'deterministic' principles that resided at the heart of classical physics. Contrary to Bohr, Heisenberg and many other physicists in the growing field of quantum physics, Einstein fervently believed that we should be able to determine where a particle is and where it will go, and that measuring these parametres would do just that – enable us to locate the particles and determine their positions as they moved through space. He starkly expressed his scepticism this way: "One could not



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possibly believe that the moon exists only when looked at." Surely, Einstein reasoned, we knew that the moon was in the sky without peering up and that we could also determine with certainty – that is, measure – where it would be in the coming days, weeks, months and years. In response to those who thought otherwise, Einstein concluded that 'hidden' deterministic variables would, upon further study, ultimately reveal the certainty in Heisenberg's uncertainty principle. That's why Einstein called it an "incomplete theory".

In his talk, Davidovich observed that by questioning the validity of the uncertainty principle, Einstein was casting doubt on the entire field of quantum mechanics. His intellect, not to mention his stature, made it impossible for others to ignore him. The vigorous debate that ensued, Davidovich noted, propelled the field forward in ways that would be difficult to imagine without Einstein's critical contribution.

Indeed it was Einstein who, together with his colleagues Boris Podolski and Nathan Rosen, co-authored an article in 1935 that introduced the concept of 'entangled' states, which they concluded was a necessary consequence of quantum physics. Simply put, the authors suggested that two particles, having interacted in the past, would somehow remain 'entangled' regardless of the distance between them. It then follows that measuring the position or momentum of one particle would allow the position and momentum of the second particle to be determined. Einstein playfully – and, it should be noted, cynically – referred to this entangled relationship as "spooky action at a distance".

Einstein's notion of "spooky action at a distance" (thus the title of Davidovich's presentation) did, ironically, provide a perfect description of the principles driving quantum mechanics. His critical insight, as a result, has helped to advance this vital field of physics over the past half century, first in the contributions of Niels Bohr and Erwin Schrödinger in 1930s, then through John Bell's findings in the 1960s, and, most recently, in cutting-edge research related to quantum computation, which some scientists believe will drive the development of ever-faster computers, and quantum encryption, which some scientists believe will provide fail-safe methods for transferring information on the internet.

Einstein's genius was present even when he was wrong.

In Davidovich's words, Einstein's genius was present even when he was wrong. Just another reason to celebrate one of the world's most gifted minds. ■

G77 AWARD

• TWAS and the Group of 77 (G77) in New York have launched the G77 Award for Science, Technology and Innovation to recognize and honour individual scientists, technologists and innovators from developing countries whose research work has contributed significantly to critical problems in science, especially in cutting-edge fields. **Pedro Antonio Prieto-Pulido**, a physical scientist from the *Universidad del Valle*, Cali, Colombia, is the first recipient of this award. He is being honoured for his contribution to the research and development of materials science and electronic devices, particularly for his work on magnetism and the physics of superconductivity at high temperatures. Prieto will be presented with the award at the general assembly of the G77 scheduled to take place at the UN headquarters in New York, USA, in September 2006.

DEL PINO HONOURED AGAIN

• Just days after receiving a TWAS Medal from President Mubarak of Egypt during TWAS's 16th General Meeting in Alexandria (see pages 8 and 29-31), **Eugenia del Pino Veintimilla** (TWAS Fellow 1989) received another award, this time from Alfredo Palacio, President of Ecuador. "Each year, the mayor and city council of Quito honour citizens who have contributed to the cultural life, sciences, sports and social aspects of the city," explains del Pino. Specifically, del Pino was presented with the Eugenio Espejo Medal, the highest recognition that Quito gives to contributions in the sciences. She

Eugenia del Pino Veintimilla

is being honoured for her wide-ranging contributions to developmental biology, the conservation of the Galapagos Islands and the education of young scientists in Ecuador.

VIJH ELECTED PRESIDENT

• **Ashok Kumar Vijh** (TWAS Associate Fellow 1987) has been elected president of the Academy of Science of the Royal Society of Canada. As president of the Academy of Science, which has about 1,000 fellows, Vijh also becomes one of the vice presidents of the Royal Society of Canada. Vijh is currently *Maître de Recherche* at the *Institut de Recherché d'Hydro-Québec* and invited professor at the *Institut Nationale de la Recherche Scientifique* of the University of Québec. Vijh's research has earned him a worldwide reputation in electrochemistry. His insight in adopting and adapting concepts and methodologies from solid-state physics, applied from the field of physical chemistry, has allowed him to make a number of original and innovative contributions. He is also well known as a forceful advocate of the importance of fundamental research in Canada and has written on such themes as science and ethics and the unity of creative processes in art and science. Vijh's term as president of the Academy of Science of the Royal Society of Canada runs until 2007.

Ashok Kumar Vijh

Habib Firouzabadi

FIROUZABADI HONOURED

• The Organization of Islamic Conference (OIC) Committee on Development of Science and Technology has named **Habib Firouzabadi** (TWAS Fellow 2000) Chemist of the Year 2005. Firouzabadi, a professor at Shiraz University, Iran, and a member of the Iranian Academy of Sciences, has published more than 200 refereed papers, including many in his specialist area of catalysis and redox reactions. He will receive his award during a special ceremony to be held in Karachi, Pakistan.

SCIENCE IN LESOTHO

• **Moeketsi Mpholo** has been awarded a TWAS Prize for Young Scientists in Developing Countries by Lesotho's Department of Science and Technology. Mpholo, of the Department of Physics and Electronics, National University of Lesotho, is currently working on two projects. His major focus, in collaboration with Cambridge University, UK, involves developing an electronic chip to analyse blood and other biochemical samples. "We have successfully managed the first step," says Mpholo, "building a working pump that uses passive electric fields to transport the fluid." He is also developing a computer simulation model designed to reveal exactly how the pump will operate. Mpholo's other project focuses on the simulation of radio signals in Lesotho. "One of the major problems for radio systems is determining how reliable and extensive the radio waves will be," explains Mpholo. "Most of the available models were developed in countries such as Japan and the UK that have very different terrains, populations and land-use patterns compared to Lesotho," he adds. "There is a need to develop a detailed computer-based radio propagation planning tool specifically for Lesotho's mountainous terrain and sparsely populated areas." Mpholo has received support from both industry and the country's Ministry of Communications Science and Technology for this project.

CAS DOCTORATE

• **Ghulam Rasul**, a native of Pakistan and the first student to enroll in the Chinese Academy of Science's (CAS) Graduate University, has received his doctorate degree. Jointly supported by CAS, TWAS and the Commission on Science and Technology for Sustainable Development (COMSATS), Rasul travelled to China in 2000 as a visiting scholar to carry out research at the CAS Institute of Atmospheric Physics. A year later he enrolled in CAS Graduate University while remaining at the Institute of Atmospheric Physics to work on his project, 'Diagnostic analysis and numerical simulation of disastrous weather in south Asian summer monsoons'. Formerly associate director of the Pakistani Meteorological Administration in Islamabad, Rasul now expects to make significant contributions to meteorological research in his home country and to promote additional scientific exchanges between Pakistan and China.

Ghulam Rasul

IAP WATER MEETING

• The InterAcademy Panel (IAP), in collaboration with the Spanish Royal Academy of Sciences, will hold an International Symposium on the Sustainable Use of Ground Water from 24-27 January 2006 at the University of Alicante, Spain. The meeting is part of IAP's Water Programme for 2004-2006. A host of international experts will discuss different issues concerning the use of water resources, especially groundwater, as it relates to agriculture, industry, national development and the conservation of aquatic ecosystems. The meeting has been organized by the Spanish Royal Academy of Exact, Physical and Natural Sciences and the Geological and Mining Institute of Spain. Other issues to be discussed during the meeting will include 'Institutions for Groundwater Management' – the promotion of which is a central component of the IAP Water Programme, especially in developing countries (see *TWAS Newsletter* vol. 17, no. 2, 2005, pages 32-38).

EURO PROPOSAL

• In June 2004, the European Commission launched 'Plants for the Future', a multidisciplinary platform of public and private partnerships aimed at increasing investment in research and innovation and to boost European competitiveness in relevant industrial sectors. TWAS participated along with a broad group of stakeholders representing research institutions, industry, farmers, regulatory authorities and consumer representatives. Specifically, TWAS helped ensure that the voice of developing countries was not overlooked in the discussions of the consortium. The first report of the 'Plants for the Future' platform, which focuses on the production of healthy, safe and sufficient food and feed while securing sustainable agriculture and developing green products such as biomaterials and biofuels, was published in

December 2005. It is available online at *www.epsoweb.org/Catalog/TP/TP%20Documents.htm*.

Hugo Hoenigsberg

SYMPOSIUM IN COLOMBIA

• **Hugo Hoenigsberg** (TWAS Fellow 1989) is currently organizing the First International Symposium on Molecular Development and Stem Cell Research, to be held in Bogota, Colombia, from 13-16 March 2006. For additional information, visit *geocities.com/igebm* or contact *hoenisbe@umb.edu.co*.

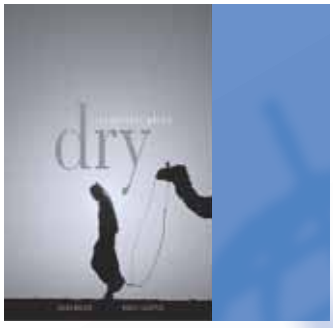
NEW PUBLICATIONS

• In collaboration with Harvard University Press, TWAS has published a large-format, full colour book called *Dry: Life Without Water*. The book features a collection of 16 case studies, many based on research conducted during the three-year Third World Network of Scientific Organizations (TWNSO) project on biodiversity in arid and semi-arid lands funded by the United Nations Environment Programme (UNEP) Global Environment Facility (GEF). For additional information, visit *www.hup.harvard.edu/catalog/MASDRY*.

• TWAS and the International Council for Science (ICSU) have collaborated with the Science Council of the Consultative Group on International Agricultural Research (CGIAR) to produce a 54-page report on *Science for Development: Changing Contexts, New Opportunities*. The document can be downloaded from *www.sciencecouncil.cgiar.org/publications*.

• The *UNESCO Science Report 2005* is now available and includes a contribution detailing the current situation in Africa co-authored by TWAS executive director, **Mohamed Hassan**. **Adnan Badran** (TWAS Fellow 1991) has also contributed a chapter on the Arab States. For additional information, visit *publishing.unesco.org/details.aspx?Code_Livre=4423#*.

• The second edition of the *Disease Control Priorities Project* will be launched during the General Forum of the InterAcademy Medical Panel (IAMP) in Beijing in April 2006. The first edition, which examined the priority of 25 health conditions based on their public health significance and the cost-effectiveness of preventive and patient management interventions in developing counties, was published in 1993. Contributions to this updated edition have been received from experts nominated by IAMP member academies. For additional information, see *www.fic.nih.gov/dcpp/*.



Dry: Life Without Water

UNESCO Science Report 2005

GLOBAL SCIENCE CORPS

• A workshop examining the concept of a Global Science Corps took place in Nairobi, Kenya, on 16-17 January 2006. Funded by the Science Initiative Group (SIG), based in Princeton, New Jersey, USA, and the United Nations Development Programme Special Unit for South-South Cooperation (UNDP-SSC), the workshop examined various mechanisms for promoting North-South scientific exchanges and the development of fellowship programmes. The concept of a Global Science Corps was first proposed by Nobel Laureate Harold Varmus (Physiology or Medicine 1989), former head of the National Institutes of Health and currently president of the Sloane Kettering Institute in New York, USA. For additional information, see *www.globalsciencecorps.org*.

WHAT'S TWAS?

The Academy of Sciences for the Developing World (TWAS) is an autonomous international organization that promotes scientific capacity and excellence in the South. Founded as the Third World Academy of Sciences by a group of eminent scientists under the leadership of the late Nobel Laureate Abdus Salam of Pakistan in 1983, TWAS was officially launched in Trieste, Italy, in 1985, by the Secretary General of the United Nations.

TWAS has more than 800 members from 90 countries, 73 of which are developing countries. A 13-member Council is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a small secretariat, 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. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is 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 science and scholarship.

TWAS was instrumental in the establishment in 1988 of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of 160 scientific organizations from developing 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. **www.twnso.org**

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 2,500 women scientists from 87 developing countries. Its main objectives are to promote research, provide training, and strengthen the role of women scientists in decision-making and development processes in the South. The secretariat of TWOWS is hosted and assisted by TWAS. **www.twows.org**

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 90 science academies worldwide established in 1993, whose primary goal is to help member academies work together to inform citizens and advise decision-makers on the scientific aspects of critical global issues. **www.interacademies.net/iap**

The secretariat of the InterAcademy Medical Panel (IAMP), an association of 52 academies of science and medicine, relocated to Trieste in May 2004. IAMP and its member academies are committed to improving health worldwide, especially in developing countries. **www.iamp-online.org**

WANT TO KNOW MORE?

TWAS and its affiliated organizations offer scientists in the South a variety of grants and fellowships. To find out more about these opportunities, check out the TWAS website:
www.twas.org

FELLOWSHIPS

Want to spend some time at a research institution in another developing country? Investigate the fellowships and associateships programmes:
www.twas.org/Exchange.html
TWOWS offers postgraduate fellowships to women from least developed countries (LDCs) and other countries in sub-Saharan Africa:
www.twows.org/postgrad.html

GRANTS

Are you a scientist seeking funding for your research project? Then take a look at the TWAS Research Grants scheme:
www.twas.org/mtm/RG_form.html
Is your institution seeking funds to collaborate with a research institute in another country in the South? The TWNSO grants programme may be able to provide support:
www.twnso.org/grants.html

EQUIPMENT

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

TRAVEL

Would you like to invite an eminent scholar to your institution, but need funding for his/her travel? Check out the Visiting Scientist Programme:
www.twas.org/hg/vis_sci.html

CONFERENCES

Are you organizing a scientific conference and would like to involve young scientists from the region? You may find the help you need here:
www.twas.org/mtm/SM_form.html