Scientists for a better world

Science and technology could solve some of the developing world's most pressing problems. Individual scientists, by some modest efforts, could help as well.

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Last November, Vietnam opened its first production plant for the measles vaccine in the Hoang Mai District in Hanoi. This factory, funded by non-refundable aid from the Japanese government, will become operational in early 2005 and will roll out 7.5 million vaccine doses annually, ending Vietnam's dependence on imports (Ha, 2004). Measles is a deadly disease—every day, 2,000 children under the age of five die from complications caused by the disease, while a simple, effective and inexpensive vaccine has been available for more than 30 years. But Vietnam's new factory is one of few in the developing world that produces vaccines.

Although this is good news for Vietnam, it is nevertheless a sad note for countries that are still dependent on vaccine makers in developed countries. And how long will it take for other, similarly important, technologies to reach developing countries and ease their burden of disease? How many post-9/11 restrictions will block the transfer of such technologies for fear of misuse? How many patent rights will have to be broken? And last but not least, how many scientists from developing countries will have to return to their homeland to develop technology into useful applications for their countrymen? These are just a few factors that hold back scientific progress in developing countries. Because many Western governments are not particularly interested in transferring their advanced technologies to the developing world, a major question is whether scientists in the developed world could help instead. I am a scientist, and I believe that science can make this world a better place for the billions of people who still live on less than US\$1 per day without access to clean water, sanitation or healthcare, and who suffer most from the

Fig 1 | A happy Soninké girl in the village of Khabou in Mauritania after the opening ceremony of the Khabou Healthcare Center. (Image courtesy of Jeremy Simpson, EMBL, Heidelberg, Germany.)

onslaught of infectious diseases (Fig 1; Serageldin, 2002). This article presents some ongoing activities by scientists and scientific organizations that are helping poorer countries, but also some actions that we could take without too much effort—from recycling simple lab equipment to establishing small research collaborations—to help our colleagues in Africa, South America and Asia.

First, we should remember that the developing world is not a big area of poor countries in the South, but a mosaic of nations with a wide variety of

economic, social and scientific factors (Moreno-Borchart, 2004). These range from Sierra Leone (gross national income (GNI) per capita of US\$520) to Chile (GNI per capita US\$9,820; www.cia.gov). So-called 'middle-income' countries, such as Brazil, China and India, have already progressed remarkably in establishing their own research base. But most low-income countries effectively have no notable research and development (R&D) activities.

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At the same time, various organizations and international meetings now recognize science, technology and education as important factors for the advancement of developing societies (Global Forum for Health Research, 1999; Hin & Subramaniam, 1999; Archibugi & Pietrobelli, 2003; Iaccarino, 2004). Beyond that, science and education also have the potential to overcome other problems that limit a nation's progress. David Hamburg, former President of the Carnegie Foundation (Stanford, CA, USA) and 1996 recipient of the US Presidential Medal of Freedom, once said "A determined international effort to foster democratic socio-economic development can do much in the long run [...] Young people can then see a basis for hope, can acquire constructive, useful, marketable skills and take advantage of

tangible opportunities for a better life. Then perhaps their need for scapegoats will diminish and their susceptibility to hate-inciting demagogues would be less" (Alberts, 2002).

The reality, however, is that active research in a developing country is an everyday struggle and often nearly impossible. Problems start at the earliest stages of a scientific career, when it is hard to obtain even minimal practical experience on account of a lack of equipment and supplies. This forces many students to apply to universities in Europe and the USA and if they ever return, they find that salaries are low, equipment prices are higher than in European countries (Schillinger, 2004) and ordered supplies may never arrive. The lack of scientific societies and the lack of interest by local governments further exacerbate the situation. Our colleagues in these countries do their best to cope: old equipment is recycled and repaired, their creativeness in circumventing missing tools or supplies is admirable and supplies are stretched to the limit to perform research (Harris, 2004; Reid & Hayes, 2004). Instead of suffering, many simply leave. Zimbabwe trained 1,200 doctors in the 1990s, but only 360 are reported

to practice in the country (Couper, 2002). And the problem is made worse for health professionals in Ghana, Kenya, Uganda and Zambia by active recruitment to the developed world through local and professional papers (SARA, 2003).

Science is, as Bruce Alberts once commented, "a global public good" (Alberts, 2002) and should therefore be freely available to everyone. Over centuries, the scientific community has developed a culture of sharing knowledge, material, protocols and information with no consideration for race, culture, ethnicity or religion. But the terrorist attacks of 11 September 2001, in New York, NY, and Washington, DC, USA, have begun a new era in which xenophobic views and protectionist policies have become prevalent (Brumfield, 2004). The US government has started a series of initiatives to engage its scientific community in counterterrorism research and to limit the flow of scientific knowledge or technological advances to prevent its abuse by terrorist groups (Leshner, 2003; Alberts & Fineberg, 2004). Moreover, the USA has issued further restrictions on student visas due to fears of

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terrorism, which affect students predominantly from Arab countries but also from China. This massively limits the possibilities for scientists from developing nations to learn essential techniques and apply them in their own countries, where they are most needed (Leshner, 2003).

It is not only military and anti-terrorist research that impinges on academic freedom; commercial pressures also take their toll on the information flow (Caplan, 2005). Patenting is now common in research. This is a normal side effect of a society intent on reaping economic benefits from its R&D investments, but it directly affects scientific values such as knowledge sharing. From the developing world's point of view, this creates an awful situation when it comes to applying knowledge created there to solve the problems of poorer countries. The creators of 'golden rice'—a rice crop genetically modified to produce a vitamin A precursor that could help to prevent blindness in children in developing countries—had to negotiate 44 patents, some of which were held by universities and publicly funded laboratories. More importantly, pharmaceutical companies maintain high prices for drugs, such as AZT to treat AIDS (Malakoff, 2004), and use their patent rights to prevent developing countries from producing these drugs more cheaply. This may change, however. After negotiations over drug discounts failed, Brazil, Thailand and Cuba decided to produce their own AIDS drugs at lower prices (d'Adesky, 2003) and will soon be able to export drugs and manufacturing technologies (*The Economist*, 2003).

In addition, scientists in developing countries are largely cut off from the flow of information that is the lifeblood of today's science. Their scarce funds do not allow subscriptions to journals or the acquisition of books, not to mention attending conferences, all of which isolate these people from ongoing research. But the Internet and the possibility of distributing information and knowledge at reduced cost have given rise to the open access movement. Some journals, such as *PLoS Biology*, make their content freely available whereas many others release their content after 6–12 months. Various publishing houses also support

WEB RESOURCES

hdr.undp.org

Human Development Reports edit a large number of publications about building human capabilities, measuring human progress and triggering action for change

www.oneworldhealth.org

A non-profit pharmaceutical company searching and finding safe, affordable and effective cures for neglected diseases plaguing the Third World

www.twas.org

Academy of Sciences for the Developing World promotes excellence in sciences for sustainable development in the South

www.ictp.it

The International Centre for Theoretical Physics was founded by the Nobel laureate Abdus Salam. It fosters advanced studies and research, especially in the developing world

www.ifs.se

The International Foundation for Science is a research council with a mission to build the scientific capacity of developing countries in sciences related to the sustainable management of biological and water resources

www.scidev.net

The Science and Development Network edits news and views about and for developing countries. This is a collaboration with Nature Publishing Group and is available in an easily accessible format

www.who.int

The World Health Organization is the United Nations' specialized agency for health. Its objective, as set out in its Constitution, is the attainment by all people of the highest possible level of health

www.unicef.org

The United Nations International Children's Emergency Fund is the driving force that helps build a world in which the rights of every child are realized

www.globalforumhealth.org

The Global Forum's central objective is to help correct the 10/90 gap by focusing research efforts on diseases that represent the heaviest burden on the world's health. The Forum facilitates collaboration between partners in both the public and private sectors

Fig 2 | Teaching laboratory in an Albanian University. Teachers recycled bottles from home as vials and flasks.

academic institutions in developing countries by lowering or waiving electronic subscription charges and/or waiving submission fees for their authors. Another interesting development is SciDev.Net (see sidebar), an online journal devoted to scientists in developing countries. Regardless of these efforts, many scientists in poorer countries still find it hard to download freely available scientific papers, simply because their institution does not have a computer with internet access or has only a few hours of electricity per day. Some commentators predict that the sequences of eukaryote genomes, freely available to everyone, could be a great tool for scientists in the developing world to address some of their most pressing problems (Broder *et al*, 2002; Weatherall, 2003). I find this hard to believe—if accessing a journal homepage to download a simple file is already

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challenging, the technical difficulties in accessing full genomes will be tremendous.

And even if scientists in the developing world did submit a manuscript, its chances of being published remain slim because editors and reviewers perceive their level of research expertise as low compared with Europe or the USA. This excludes those scientists from top journals unless they have something unique to trade, such as the largest collection of Ebola viruses (Leroy *et al*, 2004). Scientific journals, specifically those published by non-profit organizations, could do much more to support researchers from developing nations, such as by creating

a special section in their publications. Moreover, establishing freely accessible databases of research protocols and other material for teaching and training students would not cost too much to put together and would be a huge benefit for scientists in developing countries (BIOS, 2004).

One of the main limitations that scientists in developing countries face everyday is the lack of basic, not to mention state-of-the-art, equipment (Fig 2), while tons of outdated and obsolete laboratory equipment collect dust on the shelves and in backrooms of laboratories all over Western Europe and the USA. Some organizations, such as the Sustainable Sciences Institute (SSI) and the Federation of European Biochemical Societies (FEBS), which has a Scientific Apparatus Recycling Scheme (SARS) organized by Professor Peter Campbell, have begun to address this problem by sending unused equipment to poorer countries. These are not unique examples; many scientists from richer countries have supported their colleagues in developing countries by donating equipment (Table 1). As a graduate student at the Institut Gustave Roussy in Villejuif, France, and now as a post-doctoral fellow at the European Molecular Biology Laboratory in Heidelberg, Germany, I have sent research equipment to the Ivory Coast (2 tons), Tunisia (2 tons), Albania (1 ton) and the Ukraine (500 kg) with help from colleagues and administration staff. It is immensely gratifying work, and a great reward to receive an e-mail from a university dean to thank us for now being able to teach 50 biology students instead of 2. But these initiatives are limited, and they rely on dedicated individuals who invest considerable time and effort. Most scientists, however, find this a distraction from their bench work or from writing papers or grant applications.

The establishment of a large-scale equipment recycling scheme could greatly help scientific communities from Eastern European countries and developing nations to improve their research, and it may even help to keep students in their country of origin. No matter how old or outdated the equipment is, rest assured that our colleagues in poorer countries would nevertheless find it a huge improvement over what they are used to (Fig 2). But this will only work if we unite our efforts in collecting and repairing outdated equipment, in establishing collection schemes and collecting money to pay for the shipment.

Table 1 | Equipment recycling schemes

Organization	Website	Mission
Adéquation et Développement	adequationgermany.embl.de	A French non-governmental organization based in Paris with two branches: one in Germany and one in the USA. It provides used scientific equipment and literature and runs basic healthcare development projects
Direct Relief International	www.directrelief.org	Provides medical support via new and used medical equipment and pharmaceuticals, and supplies more than 3,000 charitable health facilities worldwide
International Aid	www.gospelcom.net/ia	The Medical Equipment Services section provides new and refurbished medical equipment, technical support, literature, training and advice, and serves a global network of mission hospitals and clinics
Scientific Apparatus Recycling Scheme	www.febs.unibe.ch/activities/SARS.htm	Reliable apparatus and scientific journals are donated by active laboratories to countries that are less well equipped and that face problems in acquiring research materials
Sustainable Sciences Institute	www.ssilink.org	SSI is developing an online database to facilitate the transfer of scientific equipment and supplies from laboratories in developed countries to laboratories in developing countries involved in their programme
TechSoup.org	www.techsoup.org/products/recycle	Hardware manufacturers who sell used equipment to non-profit organizations
World Wide Lab Improvement	www.wwlab.org	Specializes in equipping medical laboratory facilities in mission hospitals and clinics in developing countries

All of this is still not enough to overcome the specific problems that plague developing countries: first and foremost, infectious and nutritional diseases that shorten life expectancy and prevent these nations from making full use of their potential. The pharmaceutical industry is making huge investments in biotechnology to produce novel drugs, to develop new screening techniques and to unravel molecular structures, which form the basis of rational drug design. Every year the public and private sectors spend more than US\$70 billion on health research, but only about 10% of this money is directed towards tackling diseases that affect developing countries, where 90% of the world's health problems are located—the so-called 10/90 gap. Narrowing this gap should have higher priority for funding agencies and the science community to improve health, not just in the developed world, but also in the developing world. As the worldwide spread of severe acute respiratory syndrome, the spread of multi-drug resistant tuberculosis in Eastern Europe and the spectre of a flu epidemic demonstrate, rich countries will eventually be affected too—in these times of international travel, the outbreak of a deadly new disease in Africa, Asia or South America will not be confined to these places for long.

A positive initiative would be to devote more money and resources into research programmes that address malaria, tuberculosis, malnutrition and HIV/AIDS. This is not a utopia, just a simple scientific challenge. But funding remains scarce as affluent

societies focus almost solely on the health problems of their ageing citizens. As publicly funded research on most of these diseases has greatly diminished, charities have stepped in to fill the void. For example, the Bill and Melinda Gates Foundation spends more money to support research on developing world diseases than most Western governments, which has had a major impact on these fields during the past few years.

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OneWorld Health (San Francisco, CA, USA) is an example of how to engage the public and the private sector in initiatives that benefit developing countries. This non-profit organization was founded in 2000 by pharmaceutical scientist Victoria Hale to find and develop new drugs that are urgently needed in the developing world. Working with the World Health Organization (WHO) and other agencies, OneWorld Health has identified several key compounds based on molecules with proven efficacy that were abandoned by industry or academia, largely for economic reasons. One of these, paromomycin, an antibiotic developed in the 1960s, has been shown to be active against the parasite that causes visceral leishmaniasis (Thakur *et al*, 2000). This disease infects

500,000 people annually and kills about 60,000, mainly in the Asian subcontinent, Brazil and the Sudan (Desjeux, 2004). Supported by a US\$4.2 million grant from the Gates Foundation, OneWorld Health and WHO are now conducting a large phase III trial of paromomycin in India. Another example is the use of cotrimazole, a cheap and widely available antibiotic, as a prophylactic against opportunistic infections in HIV-infected children (Chintu *et al*, 2004). As Bruce Alberts and Harold Fineberg recently demonstrated, it is possible to mobilize scientists to accomplish great achievements in a relatively short period: the discovery of antivirals against smallpox is one example (Alberts & Fineberg, 2004; Harrison *et al*, 2004).

But scientists as individuals could also become more engaged in collaborations with colleagues in developing countries regardless of the specific nature of their research. Given the scarce resources there, any cooperation—be it training a student or a technician for a couple of months or just exchanging ideas, information or some materials—would be a great help to research teams in the developing world. This could also include funding agencies, as scientists have an influence as board members or peer reviewers. Considering collaboration with a developing country in a grant allowance or creating specific grants for such collaborations, even on a small scale, would be an important step and would set an example to others.

We should remember that the culture of the scientific community is based on openness and sharing, values that unite nearly all its members around the world. But the reality is that 'big' science takes place in well-funded laboratories and developed countries are able to attract the best scientists, file more patents and sustain a higher economic profile, which further deepens the trench that separates us from developing countries. Individual scientists are not necessarily responsible for this, but science itself is a fundamental part of it.

HG Wells once said "A federation of all humanity, together with a sufficient measure of social justice to ensure health, education, and a rough equality of opportunity, would mean such a release and increase of human energy as to open up a new phase in human history" (Wells, 1920). This is what we should strive for. That does not necessarily mean we should stop everything we are doing right now and start addressing the problems of developing countries and nothing else. Instead, setting new standards in the life sciences means recognizing that the knowledge we create should be shared with others to find cures and create vaccines to help overcome the onslaught of diseases. As Sydney Brenner put it: "The first [step], common to all scientists, is to tell the truth. The second is to stand up for all humanity" (Brenner, 2003). Some would argue that science is too demanding a job to do anything else, as competition for grants and publications remains high. As a postdoctoral fellow, I should probably concentrate on my scientific work, as my future depends on it, and I should leave it to others to help developing countries. But I have chosen instead to help, together with friends, colleagues and like-minded others. For me, science is like a good meal—it tastes better when you share it.

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Dr Reynaud and his Malian colleague Ousmane Karembeu during a workshop in the Malian village of Tafarciga, 2004.

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