trace amounts of highly radioactive plutonium and neptunium, without awareness, protective gear or medical evaluations. Hundreds of thousands lived outdoors near 700 burning oil-well fires for months without protection.

Whether soldiers during the recent war in Iraq were subject to the same or similar toxic exposures is an open question. Only time will tell whether veterans of the second Gulf War will suffer the same illnesses as those from the first. "If they do, the cause this time will not be a mystery," Robinson said. "Now, the only mystery connected to Gulf War syndrome is whether the Department of Defense will do what Congress told them to do." Here, he is referring to a 1998 US law that requires that soldiers receive comprehensive physical examinations, including blood tests, before and after deployment. Before the war began in March, the DoD declared that it had learned from its mistakes; the troops were being equipped with better environmental sensors and other testing apparatus, and better gas masks and suits. It also said that it would assess soldiers' health using brief questionnaires, before and after deployment. However, the protective equipment was substandard and, according to civilian health experts who testified in Congress on March 25, 2003, once-yearly blood tests for HIV do not fulfil the requirements for comprehensive examinations, which should include lab tests and X-rays immediately before and after deployment. Two days later, at the House Armed Services subcommittee, lawmakers noted that many soldiers did not even fill out the questionnaires, and Robinson said that those that did were likely to give answers that would allow them to be deployed and remain with their units. Twelve years after GWI, it seems that the military is making some of the same mistakes again. However, the DoD stated on April 29, 2003, that it would provide a more comprehensive, face-to-face examination for the returning soldiers. Calling it a "first step", Robinson and the NGWRC are still insisting that baseline data should have been collected. Soldiers who are fighting terrorism around the world should not experience the same system failures that GWI veterans continue to face, he added.

Vicki Brower

doi:10.1038/sj.embor.embor874

Local solutions for global problems

With the gap between the rich and the poor becoming wider, participants of the third bioVision meeting discussed how the life sciences can help

At the beginning of the twenty-first century, the world seems more divided than ever: the rich are becoming richer and the poor are becoming poorer. The global consequences of this stark contrast between the 'haves' and the 'have-nots', and between the developed and the developing world, was one of the main topics of the third bioVision meeting held in Lyon, France, during 8–11 April 2003. Around 2,000 representatives from science, society and industry gathered to discuss the current state of the world and to what degree biotechnology could contribute to solving the numerous problems that plague humanity.

The huge gap between the developed and the developing world is best characterized by the availability of food. Although there is plenty of food available to feed the world's population—with or without genetically modified (GM) crops—its equal distribution remains a monumental challenge. Malnutrition still affects 800 million people in developing countries and it is an important contributing factor to half of the deaths of millions of children each year from infectious diseases. Access to adequate and safe food—and, equally importantly, clean drinking water—was regarded as a basic human right by the speakers and attendees of the conference. However, as Mary Robinson, former United Nations (UN) High Commissioner for Human Rights, and Head of the Ethical Globalization Initiative in New York, pointed out, this should not equate to the free distribution of surplus food from wealthier to poorer countries, but rather to the implementation of programmes aimed at establishing sustainable development throughout the world. Robinson also suggested that any progress in these areas should be monitored by independent organizations, such as the UN. Indeed, as M.S. Swaminathan, President of the Pugwash Conferences on Science and World Affairs, commented, any state that has

signed and ratified a constitutionally guaranteed right to food for its population is then under great pressure to provide what was promised. He cited occasions in India when such a constitutional guarantee caused communities to seek and acquire aid from the Indian government.

Jacques Diouf, Director General of the UN Food and Agriculture Organization, suggested some concrete initiatives to favour economic growth in the rural communities of developing countries. Sustainable agriculture and rural development are essential for the implementation of an integrated approach to increasing food production and for enhancing food security and food safety, he explained. Therefore, local producers and farmers would be better assisted by guaranteed purchasing of their products rather than through financial aid. Such a guarantee would also be effective in transferring new agricultural technologies and

marketing techniques to small rural farms, which would enable farmers to grow and sell other high-quality products.

The lack of appropriate food in our diet is actually a global problem, which, perversely, unites the developed and the developing worlds. The growing obesity epidemic in the USA and other developed countries is putting increasing pressure on health care systems, and the annual death toll due to obesity-related diseases is estimated to exceed 300,000 in the USA alone. Solutions to this problem are obvious: people should eat less sugar and meat, and more fruit and vegetables, as Marion Nestle from New York University, USA, pointed out. Indeed, there is increasing evidence that consuming just 50 g more fruit and vegetables a day could significantly decrease an individual's risk of cardiovascular disease and cancer. Also, in the developing world, it is often not a general lack of food, but rather a dearth of nutritious and healthy food, that makes people easy prey for infectious diseases. And this is true for chronic diseases too, which sometimes manifest themselves 20 years earlier in people living in developing countries compared with those in the developed world, as John Harris, a developmental banker from the University of Manchester's School of Law in the UK, pointed out. This is usually due to a deficiency in antioxidants and micronutrients provided by vegetables. Paradoxically, although these crops are not grown in sufficient quantities in developing countries, vegetables often provide the only source of income above subsistence for small farmers in these areas. To counteract such nutritional

shortcomings, European biologists have created GM rice that produces vitamin A, which could prevent 500,000 children from becoming blind, or even from dying, each year. Similarly, the breeding of iron-rich rice and the teaching of milling methods that preserve the iron that is otherwise lost during polishing can make huge differences to the health of a community.

...local producers and farmers would be better assisted by guaranteed purchasing of their products rather than through financial aid

Several speakers stressed that improving child health is an efficient strategy for improving adult health. Heavier newborns are less likely to develop coronary heart disease later in life and seem more resistant to other diseases. China, Costa Rica and Cuba invest in preventive health measures, and life expectancies in these countries are higher and child mortality rates lower than one would expect from their general wealth. But these countries are the exception, and preschool malnutrition is now at a staggering 50% higher level in South Asia than in sub-Saharan Africa, although there is generally more food available in the former. Mahtab Bamji, a medical scientist from the Dangoria Charitable Trust in Hyderabad, India, advised increasing the awareness, accessibility and affordability of appropriate food, and reported promising results from so-called 'agri-clinics'

that have been established in India to advise farmers on how to diversify their crops. The greatest imperative now is the education of women, who are often the ones running the farm and feeding the children.

However, developed countries are not exempt from investing more into their children's health. Considering how important a good start is for a healthy life, it is incomprehensible that less than 1% of the total health costs in one's life are spent during the first year, in contrast with about 50% in the last six months. Industrialized countries are still reasonably able to cope with the increasing burden of their health systems as their ageing populations tend to have considerable monetary assets. However, now that medical treatments are becoming more and more elaborate and therefore expensive, the proposal to redistribute half of a nation's health budget by slashing support for the last six months of life produced moments of uneasy silence in the audience.

As sustainable agriculture can only be implemented in a sound ecosystem, environmental sustainability was another important topic at the meeting. Now that we are on the verge of a biological-industrial revolution, what are the appropriate measures that need to be taken to ensure that nature is still respected?

First and foremost, it is imperative to safeguard biodiversity. To this end, it was suggested that protected regions should be created in which farmers would be reimbursed for growing local crop varieties instead of high-yield biotech strains. This would conserve the existing pool of diverse plants, which are crucial for furthering our knowledge and our abilities to react to food disasters and a changing environment. Second, biotechnology could be applied differently in the developing world than in industrialized nations and hence produce different benefits. A striking example was put forward by Lothar Willmitzer from the Max Planck Institute in Golm, Germany, who described the results of planting GM *Bt* cotton, which is resistant to various pests. In the USA, only large-scale farmers use this crop, whereas it is planted by 5 million small-scale farmers in China. Crop yield has subsequently improved and pesticide use has dropped in both countries. The former has increased by 20% and the latter has dropped by 50% in China, but more significantly, the manual farming practices used there mean that 75% fewer farmers now report to local health

clinics with chemical poisoning symptoms. Therefore, whereas in the developed world the introduction of this crop is seen as an economic benefit to a minority of farmers and of little advantage to the consumer, in the developing world, GM technology can have a marked impact on health.

Biotechnology was presented as a valid approach for reversing environmental deterioration induced by the current population growth and by past misguided attempts at development. For example, industrial or white biotechnology (WB) provides a concrete and elegant example of how modern science can provide environmentally cleaner alternatives to various petrol-based processes. WB achieves this by exploiting living cells—yeast, moulds and bacteria—to produce various goods for the chemical, food, textile and other industries. In an eloquent presentation by Feike Sijbesma, from the Dutch biotech company DSM, and chairman of EuropaBio in Brussels, Belgium, WB was praised as having the potential to benefit the three main pillars of sustainability: society, the environment and the economy. Apart from providing a new technology platform and therefore creating new jobs, WB can bring about reductions in gas emissions, energy and water consumption, raw material requirements and waste production. It is a low-cost, competitive technology that is applicable to the production of a growing number of products, such as biopolymers. Polymers are traditionally produced from fossil resources, such as oil and natural gas, whereas bio-based polymers use renewable materials, such as sugars and

corn, as raw materials, and reduce fossil usage by 25–55%. Similarly, vitamin B2 is traditionally produced in a lengthy eight-step chemical process. A new WB process, developed by BASF in Ludwigshafen, Germany, consists only of a one-step fermentation: vegetable oil is fed to the fungus *Ashbya gossypii*, which metabolizes it to produce vitamin B2, which is recovered as yellow crystals. This innovative process reduces overall costs and environmental impact by 40%, carbon dioxide emission by 30%, resource consumption by 60% and waste by 95%.

But, similar to vaccine and agricultural development, the potential of WB cannot be fulfilled by industry alone. It is necessary to establish a dialogue among all stakeholders—governments, policymakers, non-governmental organizations, and so on—to discuss the opportunities, as well as any related concerns. The USA has endorsed a progressive stance towards these innovative endeavours, whereas the policies of European countries do not yet foster the development of WB. It was proposed that the European Commission should define its own approach to WB through more effective economic and regulatory frameworks and should increase awareness of its benefits and encourage its use.

...it is often not a general lack of food, but rather a dearth of nutritious and healthy food, that makes people easy prey for infectious diseases

Indeed, the problem of establishing a common ethics policy for the application of modern technologies was another widely discussed topic at the bioVision meeting. One such example is the advances in human reproductive and therapeutic cloning, in which it seems particularly difficult to unite cultures that forbid birth control through contraception with those allowing even late abortions when a genetic disease is diagnosed. Nobel laureate James Watson spoke about his frustration with the current leadership of the USA by conservative Christians, and he emphasized how important his and Crick's atheist beliefs were in elucidating the structural basis of DNA. Without a meddling God, chemistry and physics were able to explain how biology works, he pointed out. Watson's attitude towards religion has obviously not changed since then, because he asked why religious views can still influence decisions on old and emerging areas of research, such as genetic testing or stem-cell research. "It would be immoral and cruel to live with the consequences of genetic mistakes; it is only human to want to help any person to be healthy; there is little use of available genetic testing during pregnancy, less than there should be," he commented. Watson explained that the argument presented against the full use of genetic techniques is often what he called "the unquantifiable bad", that is, what happens if ill-intentioned people get hold of the technology. He urged society to go beyond the unquantifiable bad and take control of the benefits of new technologies to improve the quality of life. Indeed, he strongly emphasized the role of the individual in this respect: decisions about genetic testing or genetic enhancement should not be made by governments or religious bodies, but by individuals. Watson ended with a passionate plea against the precautionary principle in general, fearing that if those responsible for the protection of society espouse it, the fruits of research will not be properly harvested.

The aim of the bioVision meetings is to take stock of current developments in biotechnology and, clearly, many questions are still unanswered and many issues unresolved. But it is certainly important to highlight the real potential of biology and biotechnology for creating a better world for us and for future generations.

Giovanni Frazzetto & Friedrich Frischknecht
doi:10.1038/sj.embor.embor878