**Commentary on Samuel Broder's, Stephen Hoffman's and Peter Hotez's article in
EMBO reports, September 2002**

Broder *et al.* recently published an article in *EMBO reports* about new cures for the health problems of the Third World. The subtitle was even more informative: the application of genomics to the diseases plaguing the developing world may have huge medical and economic benefits for those countries and might even prevent armed conflict.

This is how we scientists are: candid! In summary, the authors of the above-mentioned article predict that genomics will finally solve some of the major problems afflicting the so-called 'Third World countries'—from infectious diseases to social unrest—and put their economies on the right track. . . to what? Among the diseases listed as examples are many so-called 'tropical diseases', as well as HIV/AIDS. The authors correctly point out that research on tropical parasites, such as hookworm, has so far been for the benefit of patients of the developed world, to control specific diseases of these countries such as stroke. This is a very pertinent demonstration of the new trends in the geopolitics of disease research.

As one reads the article, one cannot help but reflect on several statements that depict the mentality of us, scientists of western culture and capitalism: the posi-

tivistic view of science, the messianic attitude of the developed world and the pressure of capital gains to keep tightening the rope around the neck of those countries we want to save. We, supposedly 'neutral' scientists, are here to help the dream come true.

Genomics is new, yes, but what is not new is the discourse. The same statements have been made before with other scientific breakthroughs, such as penicillin, monoclonal antibodies, synthetic peptides and genetic engineering. Yes, we have the blueprints of several important organisms, but they are still in a coded form. It is therefore necessary to wait for the arrival of proteomics—and so the dream of new cures must be postponed for another 10 or more years. In the meantime, another highly important player in solving our problems, 'Education for All', as was discussed at the United Nations Conferences in Jomtien, Thailand, and again in Dakar, Senegal, is also being postponed for 15 more years.

But let us be positive and assume that the solution to malaria and leishmaniasis will be with us here in Colombia in the next year. One can wonder who will be vaccinated first: those working in the coffee-growing farms, or the guerillas and

paramilitaries? Since this is a matter of market forces, and since heroin and cocaine sell better than coffee and bananas, amapola and coca dealers will eventually be healthier than coffee and banana growers—which they already are.

And what about the health of people in the developed countries, whose major problems seem to be stroke, obesity, erectile dysfunction, etc.? Their economic health allows for a diet rich in fat and proteins from animals fed on plenty of cereals—eight pounds of quality cereal are needed to produce one pound of meat. Meanwhile, in other parts of the world, children die of hunger and disease with no cereals to eat. Still, the authors of the article are there to remind us of the report of General Slim, that without malaria it would be far easier to perform military actions in the south.

Jorge E. Ossa

Jorge E. Ossa is Professor Emeritus from the Universidad de Antioquia in Medellín, Colombia.
E-mail: jeossa@catios.udea.edu.co

DOI: 10.1093/embo-reports/kvf255

There are two possible strategies for eradicating diseases of poverty: either develop treatments and specific preventive measures, or abolish poverty. History has taught us that the former rarely works in the absence of progress with the latter. Undertaking science and technology in the developing world provides the only route to achieving both aims simultaneously. It is in this respect that the article by Broder, Hoffman and Hotez most dramatically misses the point of the opportunity offered by genomics to alleviate suffering in impoverished societies.

The authors are quite right to suggest that genomic science will have the greatest impact in developing countries, especially in relation to tropical diseases. But they are quite wrong to suggest that this technology can only be transferred downwards from well-meaning laboratories in the developed world. Advanced societies are not the sole preserve of scientific talent, and the greatest obstacle to cutting-edge research in developing countries is certainly not the geographical distribution of human intelligence. Nor is it necessarily the lack of investment. Rather, the

problems are the availability of reagents and equipment, the time needed to obtain these necessary items and the complexity of local importation barriers and controls. Thus, efforts by developing countries to compete in hypothesis-based research are almost always doomed to failure. It is very hard to have an idea that has not occurred to someone else: if two scientists—one in New York and one in Papua New Guinea—simultaneously have the same insight, the American will almost always be the first to patent and publish the results due to logistical advantages.

Genomics, however, is not hypothesis-based science, but one that leads to hypothesis generation. It also avoids the traditional logistical constraints of biomedical research: most of the data are generated by genome sequencing, a very straightforward and repetitive process where the reagents and equipment required can be predicted 6 months in advance. Even more importantly, the computational extraction of the biological value of these data—on which patents for novel drugs and vaccines are based—entirely sidesteps the major predicaments of Third World science. Indeed, bioinformatics and the internet represent a major democratizing force since the only tools required are intelligence and a personal computer. In this particular race for novel findings, I would probably back the scientist in Papua New Guinea rather than the one in New York. Clearly, functional genomics requires more infrastructure and takes time and effort to establish. Even so, basic DNA sequencing and comparative genomics will remain a strong discovery paradigm for at least a generation (Simpson, 2002), and can currently be undertaken within the relative sanctuary of prior discovery and provisional patents.

We have had the privilege of participating in this optimistic scenario. In collaboration with the state of São Paulo science foundation FAPESP, we led the consortium of laboratories that generated the first complete genome sequence and annotation of a bacterial plant pathogen, *Xylella fastidiosa*. This work was undertaken entirely within Brazil and took a little over 2 years between the importa-

tion of the first automated sequencers and submission of our manuscript (Simpson *et al.*, 2000). A network was developed that required no investment in construction or administration, and the scientific talent was already in place at local universities and institutes (Simpson, 2001).

This project has had a dramatic impact on science in Brazil (WHO, 2002). As a direct consequence of our initial genome sequencing efforts, a functional genomics programme is now defining the disease caused by *Xylella* in citrus orchards. A significant percentage of the funding for this programme has come from the citrus industry itself, setting an important precedent. The US Department of Agriculture, together with the American Vineyard Foundation, has invited the group to sequence the genome of an *X. fastidiosa* isolate that causes Pierce's Disease in grapevines. Among other genome projects, the same scientific teams in Brazil are now the single largest contributors to human expressed gene sequences currently available in the public databases and are major contributors to the annotation of the human genome (Camargo *et al.*, 2001; de Souza *et al.*, 2000).

Science is important for developing countries as it is a fulcrum for eradicating disease and creating wealth. The scientific process enhances traditional industries, and can form the basis of new companies that utilise local talent to solve both local and international problems. Ironically, I believe that the inclusion of scientists from developing countries is also crucial for researching health problems of wealthy nations. Our lack of progress with complex

diseases such as cancer renders all contributions welcome and a huge wealth of talent around the world remains shockingly under-utilised. Genomics is a major route to this end. Thus, funding agencies and philanthropic groups would certainly increase their lasting legacy in improving the lot of the poor by investing directly in their science rather than by relying on scientists in the developed world.

References

- de Souza, S.J. (2000) Identification of human chromosome 22 transcribed sequences with ORF expressed sequence tags. *Proc. Natl Acad. Sci. USA*, **97**, 12690–12693.
- Camargo, A.A. *et al.* (2001) The contribution of 700,000 OEF sequence tags to the definition of the human transcriptome. *Proc. Natl Acad. Sci. USA*, **98**, 12103–12108.
- Simpson, A.J.G. (2001) Genome sequencing networks. *Nat. Rev. Genet.*, **2**, 979–983.
- Simpson, A.J.G. (2002) Sequence based genomics. *Genome Biol.*, **3**, REPORT 4029.
- Simpson, A.J.G. *et al.* (2000) The genome sequence of the plant pathogen *Xylella fastidiosa*. The *Xylella fastidiosa* Consortium of the Organization for Nucleotide Sequencing and Analysis. *Nature*, **406**, 151–157.
- WHO (2002) *Genomics and World Health*. World Health Organization. http://www3.who.int/whosis/genomics/pdf/genomics_report.pdf.

Andrew J.G. Simpson

Andrew J. G. Simpson is Director of the James R. Kerr Program at the Ludwig Institute for Cancer Research in New York City, NY.
E-mail: asimpson@licr.org.

DOI: 10.1093/embo-reports/kvf254