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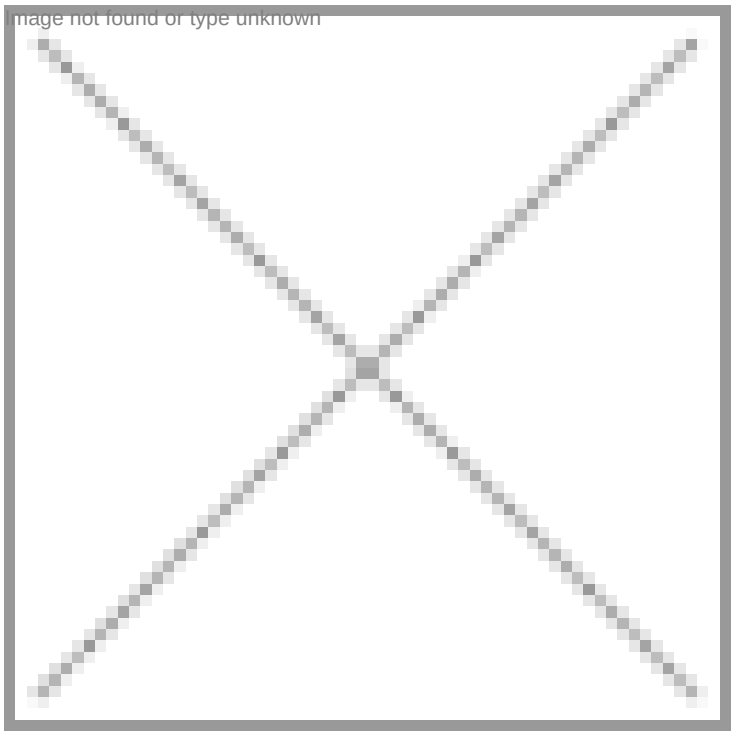

Contribute to the future of humanity

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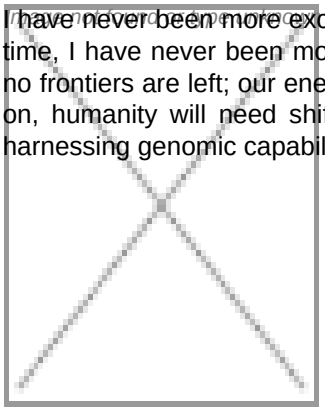

I have never been more excited about the future of biomedicine given all we know, especially about the genome. At the same time, I have never been more concerned about the survivability of the human species. We have populated the earth so that no frontiers are left; our energy supplies are dwindling, and climate change is challenging our security on all fronts. From now on, humanity will need shift from being exploiters to stewards of our resources. Fundamental to managing our future is harnessing genomic capabilities.

We are at an inflection point of discovery in genomics and in human genetics. The confluence of knowledge of the human genome sequence, the breathtaking advances in genomic technologies, comparable increases in computational capabilities, and a maturing knowledge base in systems biology are all making genome-based medicine a reality. But equally stunning are the advances in genomic applications for agriculture and veterinary medicine towards optimizing food stocks; and now synthetic biology towards generating renewable energy. Genomic technologies are becoming the prime tools in solving these problems. Genomic technologies informed by genetic sciences have become the core approach to genetic engineering, systems biology, and synthetic biology.

When we consider the medical challenges facing the whole of humanity, they will primarily be in the prevention and treatment of infectious diseases, and in sustaining human performance as our populations grow older. In the future, the challenges of AIDS, emerging pandemics, and drug resistant microorganisms will have a significant impact on the economy and the health of a nation. Just as our forbearers found a solution to the starvation cycles afflicting hunter gatherers through agriculture and mastering storage and preservation strategies, we will need to develop direct solutions to emerging infectious disease and to secure our food sources with limited arable land in order to survive. Similarly, all common afflictions of affluent societies such as type 2 diabetes, cardiovascular disease, cancer, and dementia are ailments of aging. Thus, for humanity to advance, we must find solutions to maintain our productivity in the later years of our life. Improvements in food crop and livestock production will be needed to feed the progressively enlarging masses. We have witnessed this dramatic rise in demand as Chinese and Indians raise their standard of living. Certainly, there are concerns about genetically introducing novel genes into the bio-environment. But this can be bypassed by marker-assisted-breeding where standard breeding is accelerated by using precise chromosomal markers in edible plant species. In the emerging field of synthetic biology, the introduction of entire biochemical and synthetic pathways can generate microbial reactors that can convert cellulose into fuel or algae into biodiesel feedstock.

All these possibilities can be realized by genomic strategies and advances in genomic technologies: in genome-wide genotyping and ultra-high throughput sequencing, all accessible at a low cost. When compared to standards of 1990, when the human genome sequencing effort began, the total cost of sequencing has fallen by six orders of magnitude with a proportionate increase in speed. Our ability to assess single nucleotide polymorphisms used to map disease genes are now into the one million SNP per sample range. Taken together, these changes in speed, cost, and comprehensiveness will dramatically change our ability to do genetic-based medicine and plant biology.

In the twentieth century, most of the innovation and scientific activity occurred in the west and in Japan. However, in the last 15 years, we have all observed a dramatic change in the global economic and scientific landscape. The emerging economies of India, China, South Africa, South America, Eastern Europe and the Middle East have risen in economic clout and are putting these resources into nurturing scientific talent and in building biomedical research infrastructure. Many governments have the desire to exploit genomic technologies for public health benefits, for capacity building in biomedical investigations, in environmental remediation, and in agricultural advancement. I believe this is a correct strategy. Modularly deployed and cost effective, high throughput sequencing and genotyping approaches can be readily established, and informatics capabilities are accessible and expandable. The technologies can easily be directed to other non-medical applications such as in agricultural development, in animal-live stock management, and in environmental remediation. This was indeed well exploited by Brazilian scientists in Sao Paulo in year 2000 when they leapfrogged into world prominence by sequencing an agricultural pathogen (the genome sequence of the plant pathogen Xylella fastidiosa). So, genomic approaches are cost effective means to raise the scientific profile of a new entrant into competitive biology and to help solve national challenges (Simpson AJ. Genome sequencing networks. Nat Rev Genet. 2001 Dec; 2(12): 979-83).

With this real and projected increase in genomic research activity, the need for a global organization that can act as a platform for sharing information and for debate has never been greater. In many ways, like nuclear energy, the possibilities for good are significant, but the dangers the technologies hold can also be fearsome. For this reason, the role of organizations such as the Human Genome Organization (HUGO) is more relevant and important than ever before (http://www.hugo-international.org/).

Formed in 1991, HUGO was established by an international community of scientists to advise governments in the sequencing of the human genome and to discuss the social consequences of this knowledge. Now in its 17th year of existence, HUGO is refocusing on two exciting directions--genomic medicine (that extends beyond human disease to environmental remediation and food sustainability) and the emerging economies of the world.

As I have argued in this essay, human sustainability will be our paramount challenge and genomic technologies will be a key to this sustainability. Thus the time for Genome Medicine has arrived and the need for HUGO, as a thoughtful and international arbiter, has never been greater. HUGO's second focus on supporting the growth of genomic capabilities in the

emerging and developing countries in Latin America, Eastern Europe, Asia, and Africa is timely. The dramatic economic development in most of these emerging economies now is permitting governments to reinvest into science and technology. There is a need for a global organization to help all societies craft the most mature application of genomics in medicine and public policy.

Therefore, I invite all my readers to join HUGO and to contribute to the global discussion on genomics and the future of humanity (http://www.hugo-international.org/).