

## The human genome revolution or evolution?

Claude Besmond and Marc Fellous\*

*Human Immunogenetic, Institut Pasteur 25, rue du Dr Roux, 75724 Paris Cedex 15, France*

At the time of publication, the draft of the human genome sequence will have been released. Beyond the anecdotal event that it is coincidental with the year 2000, the availability of this draft is an evolution rather than a revolution that proceeds from Socrate's famous motto "Know yourself" and constitutes a significant milestone of our journey towards an even more self-conscious humanity.

A considerable amount of international effort has been necessary to produce this multibillion items database which indeed contains an extraordinary yet uncovered wealth of information that will provide an unprecedented input towards a better knowledge of human biology and physiology. However, before we reach a global molecular vision of the physiological processes, we must develop a number of predictive and simulation tools that are based on computational approaches. Indeed, in the genomic era we face a reversed paradigm where keyboards and computer screens are increasingly used as the biologist's work bench and where wet biology will serve for testing *a posteriori* hypotheses made in silico. Another really interesting challenge, but undoubtedly a much more difficult one, resides in finding a role and revealing some hidden internal and perhaps spatial code for most of the genome that is not related to genes. The genome is indeed not only linearly organized but show fractal orders of organization that could each have their own functional role.

The human body is an open system and a true cellular physiological representation will have to include, in addition to physiogenomics and functional genomics, that is, gene function and regulations within the cell, the networks of intracellular interactions of all kinds as well as environmental influences and interactions with all sorts of pathogen organisms, for example. This huge amount of nonlinear investigation (as opposed to sequencing) that remains to be done will keep us busy for a number of years. It will also necessarily require the development of nondestructive methods that will allow watching the inside from the outside. Therefore, after enlarging its frontiers towards the informatics field, biology will have to turn to the science of signal interaction, that is, physics. In this long run of interdisciplinary walk, we must

expect that, at sometime we also become theoretical biologists or mathematicians. We can dream, as the prisoner Tzinacan in the novel "The writing of the God" by Jorge Luis Borges who, due to forced isolation and meditation, reaches a point where he understands the whole universe as a single coherent equation, that our efforts, conjugated to the contribution of more fundamental sciences, will lead to a modelisation of a whole cell, a group of cells, or a whole physical body as an equally coherent equation.

The ability to rapidly determine the complete DNA sequence of any particular individual is surely not very far away given the pace at which technology advances. When we reach this time, it will be possible to examine the total genetic pattern of individuals and establish a genetic profile in terms of susceptibility to infectious diseases, development of cancer or late onset diseases, for example. This medicine by anticipation should lead to the development and the application of very specific treatments adapted to particular genetic profiles, what may be called individual medicine. However, in the meantime, we also have to deal with the responsibility that always comes with new knowledge that can be used for the best and for the worse. For now, it is indeed a source of hope but we also have to manage it so that it benefits the largest number. In this regard, we must also be very cautious that the generation and use of genetic profiles from individuals be not perverted towards particular interests. While some of us, like DNA doctors, are sharpening their tools in order to cure affected genomes to alleviate some heavy burdens on humanity, some important ethical issues are still awaiting us, among which the reductionist tendency to identify a human being with its own DNA and the temptation to intervene on DNA or to perform "quality controls" for reasons related to social or economical issues.

---

\* E-mail: [mfellous@pasteur.fr](mailto:mfellous@pasteur.fr)

Fax: +33 1 40 61 31 53

Tel: +33 1 45 68 85 37, +33 1 45 68 85 76



**Hindawi**

Submit your manuscripts at  
<http://www.hindawi.com>

