Foreword

At the time of writing this foreword (June 1998), the genome of 15 unicellular species have been completely sequenced and made available to the scientific community: ten *Eubacteria*, four *Archaebacteria* and yeast, the only eucaryotic cell so far.

During the last three years, the amino acid sequences from over 35,000 proteins uncoded by these genomes have been deciphered. More than 10,000 proteins thus unveiled have an unknown function and are members of new protein families yet to be identified. The sequence of each new bacterial genome (with the possible exception of *E. coli*) provides the microbiologist with a huge amount of fresh metabolic information, far in excess of that already in existence. A surprisingly large biochemical diversity in the bacterial world has been revealed. If over a million bacterial species exist, of which only approximately 3,000 have so far been cultured, then the enormous task of identifying the bacterial world through the sequencing of its genomes is still to be accomplished. Dozens of sequencing centers (rapidly expanding to become hundreds in number) all over the world are undertaking this task, which will result in the discovery of thousands of new proteins. These figures do, however, call into question the exploitation of this data.

Each one of these bacterial genomes forms a tier of biotechnological information, the exploitation of which will create new catalysts, hopefully more efficient and more specific, but less detrimental to the environment than most of the chemical processes currently in use. When the plant and animal kingdoms have been fully exploited by the human race, the domestication of a still largely-unexplored and immense world will remain — that of the *Eubacterial* and *Archaebacterial* kingdoms.

In the next few years, a considerable portion of the sequencing of bacterial genomes could be performed in developing countries, where labor costs are low. It is, however, to be expected that the industrial exploitation of this newly available knowledge will continue to be carried out primarily by large multinational corporations. Whatever the outcome, the race for the identification and exploitation of new microbial enzymes is on; we can only hope that, *in fine*, it will be beneficial to mankind as well as to the preservation of other living species. Equally important as the production of new industrial enzymes, newly acquired panoramic knowledge of pathogenic microbial genomes will considerably speed up the development of new vaccines and antibiotics.

In addition to harnessing of the bacterial world, it is easy to imagine the quantitative and qualitative increases in plant productivity which will result from the complete knowledge of the genomes of some one hundred plant species, which currently constitute the core of our food source. Moreover, it is possible to predict the elimination of the potent parasites currently responsible for the untimely deaths of millions of people each year by thoroughly understanding of their metabolism. This knowledge will not be complete until their genomes have been sequenced.

So, what will the repercussions on the medical world would be, that will be brought about by knowing the sequence of all the proteins constituting over 200 cell types which make up the human body? All the large pharmaceutical companies are investing heavily in medical genomics, from which they are hoping to create new drugs, new diagnostic tools and new genetic treatments. The extent of these investments is somewhat surprising, as mentioned by Philippe Goujon in his book, since the financial return appears risky and, at best, will only be obtainable in the long term. I am, nevertheless, convinced that the reading of the human genome is a necessary (though not, of course, the only) step in the molecular biology of all essential human biological functions, which sooner or later will be used to the benefit of medical knowledge and ultimately mankind.

This optimism is justified by my belief in the intrinsic value of scientific knowledge and by the extraordinary progress in molecular genetics in the past 25 years. It has flourished from the first genetic transformation of

bacteria to the first complete sequence of microbial genomes, including yeast, and will lead to the complete sequence of the human genome, hopefully, by the year 2005.

In the following pages, the science historian Philippe Goujon describes, in detail, the action taken by the European Commission in the domain of biotechnology. He has compiled a comprehensive amount of documentation and has dug deep into the archives and the memories of pioneers such as Fernand Van Hoeck, Dreux de Nettancourt, Etienne Magnien, Ati Vassarotti and Mark F. Cantley, who were (or are still) key players in the birth and development of biotechnology programs at the European Commission. Philippe Goujon has placed this European effort in a scientific, sociological and industrial context going back to the beginning of the 20th Century. Although the European effort has become much more prolific than initially predicted, Philippe Goujon highlights the still dominant contributions of the United States of America and multinational corporations to the massive industrial exploitation of molecular biotechnology which, after a first half-century of progressive implementation, will undoubtedly triumph during the 21st Century. Philippe Goujon, an informed observer, meticulously describes the succession of scientific discoveries which have resulted in the recent discovery of the complete sequence of genomes. Finally, as a scientific philosopher, he makes his position clear on the future of genomics and its possible implications. He also gives a concluding analysis of the role of science in our society.

This comprehensive analysis, based on remarkable documentation, is a massive and unique undertaking. I am pleased to have been able to foster the writing of a book which, I believe, will become a classic in the contemporary History of Science.

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