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GENOMES to LIFE

ACCELERATING BIOLOGICAL DISCOVERY

Program proposed by the
Office of Biological and Environmental Research
and
Office of Advanced Scientific Computing Research
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Having the complete DNA sequences of genomes for organisms ranging from humans to mice to microbes now brings us to perhaps the greatest scientific frontier ever. The aspiration of the biology for the 21st century is to build from the foundation of whole-genome sequences a new, comprehensive, and profound understanding of complex living systems.

This objective can be achieved only by joining revolutionary technologies for systems-level and computational biology. A central goal of the Genomes to Life program introduced in these pages is to establish, within a decade, a national infrastructure to transform the tremendous outpouring of data and concepts into a new computationally based biology. The U.S. Department of Energy's (DOE) offices of Biological and Environmental Research (BER) and Advanced Scientific Computing Research have formed a strategic alliance to meet this grand challenge.

Genomic and advanced technological resources provide an opportunity for DOE to more effectively address its broad mission needs—produce energy, sequester excess atmospheric carbon that contributes to global warming, clean up environments contaminated from weapons production, and protect people from energy byproducts such as radiation and from the threat of bioterrorism. Until now, solutions have focused on physical and engineering strategies, but many of these missions have a basis, and possibly a solution, in the biological world.

Microbes, for example, make up most of the earth's biomass, have evolved for some 3.7 billion years, and have been found in virtually every environment. The diversity and range of their adaptations mean that microbes long ago "solved" many problems for which scientists are still actively seeking solutions. Their capabilities will offer an astonishingly diverse set of biological tools.

In this booklet, we offer a roadmap for these new explorations in "systems biology." The 10-year program aims to use DNA sequences from microbes and higher organisms, including humans, as starting points for systematically tackling questions about critical life processes. Success in this quest will require joining powerful new biological, mathematical, computational, engineering, and physical concepts, approaches, and technologies and using the capabilities of other federal agencies as well.

DOE facilities and research supported at its national laboratories and in academic institutions played key enabling and scientific roles in the genomics revolution. We are again poised to make important contributions to the next revolution in biology. We are grateful to the many scientists who contributed to the development of this new program—they are the pioneers who will help lead the way.

This roadmap was prepared under the auspices of BER in response to recommendations set forth in the BER advisory subcommittee's report "Bringing the Genome to Life" (August 2000). The subcommittee, chaired by Ray Gesteland (University of Utah), acted in response to a letter from the director of the DOE Office of Science (November 1999).

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