Preface

Systems biology has emerged as a highly interdisciplinary field that has created broad enthusiasm in the scientific community. Systems biology is in vogue because of its potential to revolutionize not only biology but also medicine. Developments are anticipated that will change how we think about disease and how we approach therapeutic intervention. Perhaps the boldest vision of this future is presented by Dr. Leroy Hood, President of the Institute for Systems Biology in Seattle. He has been a protagonist and the main driving force of the underlying concept. According to Dr. Hood, systems biology will make possible a new era of medical care comprising predictive, preventive, personalized and participatory (P4) medicine. While this vision appears futuristic, it has enticed both academic scientific communities and pharmaceutical industry R&D organizations.

Systems biology ultimately attempts to understand biological systems at the molecular level. Examples of such systems are subcellular regulatory circuits with all their components, cells, organs, as well as entire organisms. Over the past decade, technologies have been developed that enable systems-level interrogations, e.g., gene expression profiling, proteomics, and metabonomics, to name a few. Scientists have used such platforms to accumulate a tremendous amount of data. Although we have learned a great deal by collecting such detailed information, it seems our understanding has not similarly increased.

The P4 concept, albeit very challenging, does offer focus on what needs to be changed to realize this vision at affordable costs. Massive amounts of data need to be managed, integrated, appropriately interpreted and modeled in the context of the individual and its surroundings. Major technology advancements are required, for instance, to routinely sequence individual human genomes. The undertaking is huge and will most likely take a generation of nontraditionally, cross-disciplinarily trained scientists to achieve the major goals.

The challenges that lie ahead include the design of platforms that are capable of integrating and analyzing data from these very different sources. While visualization of such integration may already result in some clues, statistical analysis and computational modeling are required to detect what is nonintuitive and thus open for surprising discoveries.

Furthermore, more quantitative biology is needed. For instance, it is important to generate data delineating quantitative relationships to better characterize in vitro model systems that are used for early decision making in the pharmaceutical industry. Such data are also required to build and test solid models that enable better interpretation. These models also allow access to understanding the additional levels of regulation that further modulate cellular phenotypes, which are commonly used as assay readouts in target discovery and validation. However, in the world of automated high-throughput technology platforms that screen millions of compounds in a day, quantitative biology appears tedious and complex, requires additional controls, and is too often dismissed as unnecessary.

Fuelled by promise and these challenges, teaching of systems biology as an interdisciplinary science has begun during recent years. Many universities and other research institutions around the world have invested in this new approach by founding systems biology departments or by starting and participating in systems biology initiatives.

In contrast, and perhaps not surprisingly given the long-term perspective and the tremendous technical and scientific challenges, management in the pharmaceutical industry has been quite skeptical about the promises of systems biology. Excitement about systems biology comes on the heels of a decade of major R&D investments into "omics" platforms that promised an unstoppable flow of novel targets as proprietary anchor points of therapeutic intervention. Return on these investments has so far been unsatisfactory. A few pharmaceutical companies have made substantial investments in systems biology, such as Eli Lilly's founding of an Institute of Systems Biology in Singapore, but most have adopted a wait-and-see approach.

The purpose of the Ernst Schering Research Foundation Workshop 61, whose proceedings are summarized in this book, was to raise awareness for systems thinking and highlight systems approaches that already are and potentially will become important to drug discovery and development. The meeting provided a unique overview of systems approaches employed in early and late phases of the drug development process in the pharmaceutical industry. The presentations focused the audience on systems biology in the context of drug discovery and development and initiated discussions on changes to current processes.

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