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Keynote Address

Biological Information and the Emergence of Systems Biology

Leroy Hood, MD, PhD
President Institute for Systems Biology

Abstract:

Biology is now beginning to be viewed as an informational science. There are two major types of biological information—the digital information of the genome, and the environmental signals that impinge upon the digital repository. Biology is about the interactions of these two types of information—across evolutionary, developmental and physiological time spans. The digital information falls into two major categories: the proteins that constitute the molecular machines of life and can build complex functional structures or interact in networks; and the *cis*-control elements in the regulatory regions of gene that control (with the help of their cognate transcription factors) the expression patterns of genes and provide the linkages and architectural relationships of gene regulatory networks (the integrators of input information from signal transduction pathways and the like with outputs to the physiological and developmental programs).

Systems biology attempts to define the elements of a system, delineate their interactions and from these come to understand how the systems or emergent properties of biological systems arise. Systems biology is global, integrative, iterative, hypothesis-driven and concerns itself with the dynamics of protein networks and gene regulatory networks.

I will consider several biological systems that we have begun to study using systems approaches and then discuss the implications for its contributions over the next 10-20 years to a new type of medicine focused on prediction, prevention and personalized care. I will also briefly present my views of the 10 grand challenges in biology for computer scientists and mathematicians.