

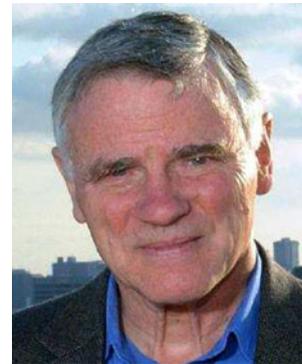
## Keynote symposium

### KS-1

Systems Approaches to Disease and the Emergence of Proactive P4 Medicine. LEE HOOD. Institute of Systems Biology, 401 Terry Ave N., Seattle, WA 98109. Email: lhood@systemsbiology.org

The challenge for biology in the 21st century is the need to deal with the incredible complexity of biological systems. One powerful way to think of biology is to view it as an informational science. This view leads to the conclusion that biological information is captured, mined, integrated by biological networks and finally passed off to molecular machines for execution. Hence the challenge in understanding biological complexity is that of deciphering the operation of dynamic biological networks and molecular machines across the three time scales of life—evolution, development and physiological responses. One approach to deciphering this complexity is to generate enormous amounts of information about the systems of interest—across the multiple scales of biological information (DNA, RNA, protein, interactions, etc.). The challenge of high throughput data centers around signal to noise issues—noise that arises both from technical constraints and from the integration of multiple aspects of biology into any measure of phenotype. I will discuss the principles and infrastructure needed to take a systems approach to disease. I will then focus on our efforts at taking a systems approach to disease—looking at a neurodegenerative (prion) disease and a brain tumor (glioblastoma) in mice. We published a few years ago a study on prion disease that has taken more than 6 yr to integrate 6 different types of data and lay out the principles of a systems approach to disease including dealing with the striking signal to noise problems of high throughput biological measurements and biology itself. From these studies come a clear understanding of some of the principal opportunities systems biology

brings to medicine and the study of disease. These include: powerful new approaches to delineate disease mechanisms, making blood a window into health and disease, the stratification of diseases into different subtypes so as to be able create an impedance match with effective drugs, a new approach to the identification of drug targets and the ability to analyze multiple organ responses to disease. Then I will discuss the emerging technologies that will transform biology and medicine over the next 10 yr—e.g., next generation DNA sequencing and its applications to human genome sequencing, targeted mass spectrometry, microfluidic protein chips, new approaches to protein-capture agents, single-cell analyses and the use of induced pluripotent cells to understand development, disease mechanisms and stratify disease. It appears that systems medicine, together with emerging technologies and the development of powerful new computational and mathematical tools will transform medicine over the next 5–20 yr from its currently reactive state to a mode that is predictive, personalized, preventive and participatory (P4). I will describe the nature of P4 medicine and its societal implications for health-care. I will also briefly mention some of the strategic partnerships that we have developed to bring P4 medicine to patients.



Lee Hood