

Biological Applications of Advanced Strategic Computing (BAASiC)

High-Level Overview

 Lawrence Livermore
National Laboratory

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A Predictive Biology capability is within our reach and brings together unique strengths : **Computing and Life Sciences**

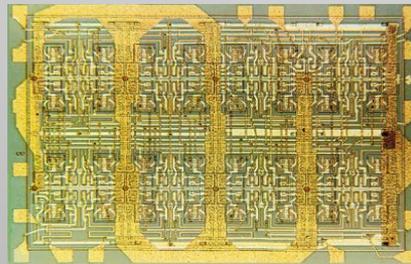
The Opportunity

Apply the power of extreme computing, big data analysis and the revolutionary growth in knowledge in the life sciences to enable precise and predictive simulations of human biology.

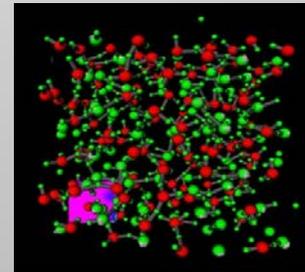
A predictive biology capability will only be possible through a new generation of simulation tools and approaches able to address a problem of unprecedented scale and complexity.



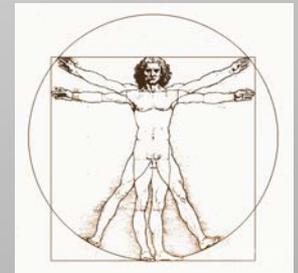
Aircraft Design



IC Design



Stockpile Stewardship



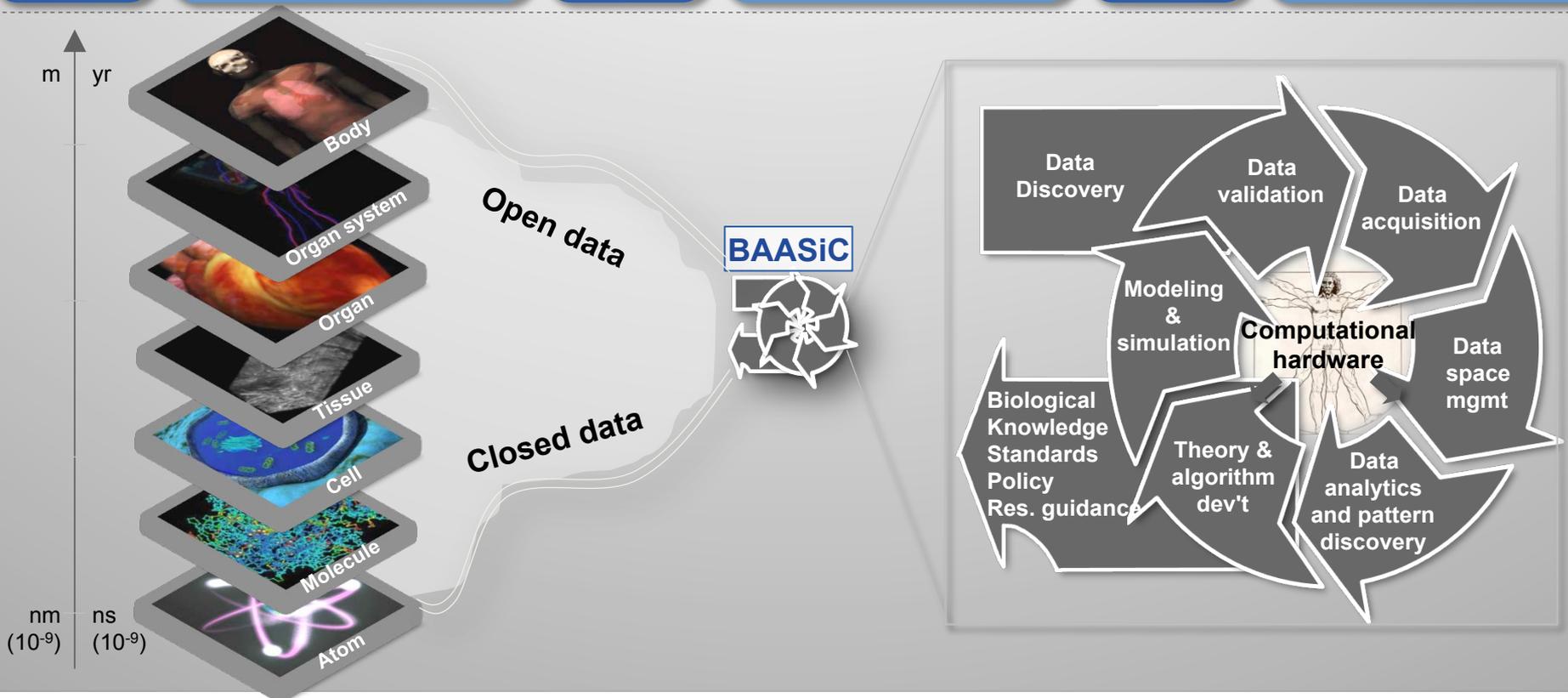
Predictive Biology

Changes in high performance computing, data sciences and sensing biological complexity are enabling for predictive biology



A public private partnership can achieve the vision

BAASiC will drive disruptive improvement in biomedical value chain through predictive biology



Science: BAASiC's predictive biology vision brings together four science program elements

Predictive physiology

- Provides understanding of **normal human physiology**

Predictive pathophysiology

- Provides understanding of how normal physiology **perturbed by disease**

Predictive pharmacology

- Provides understanding of **drug compound impacts** at molecular through organ level

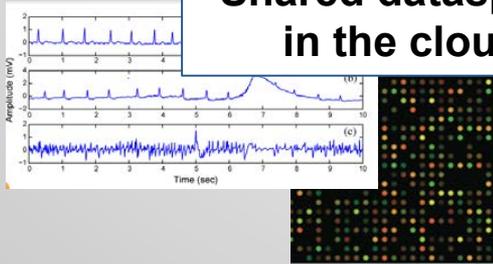
Predictive pathogen biology

- **Model pathogens** from a molecular to a population level

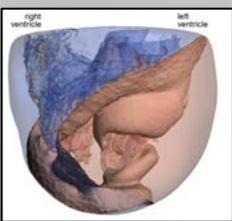
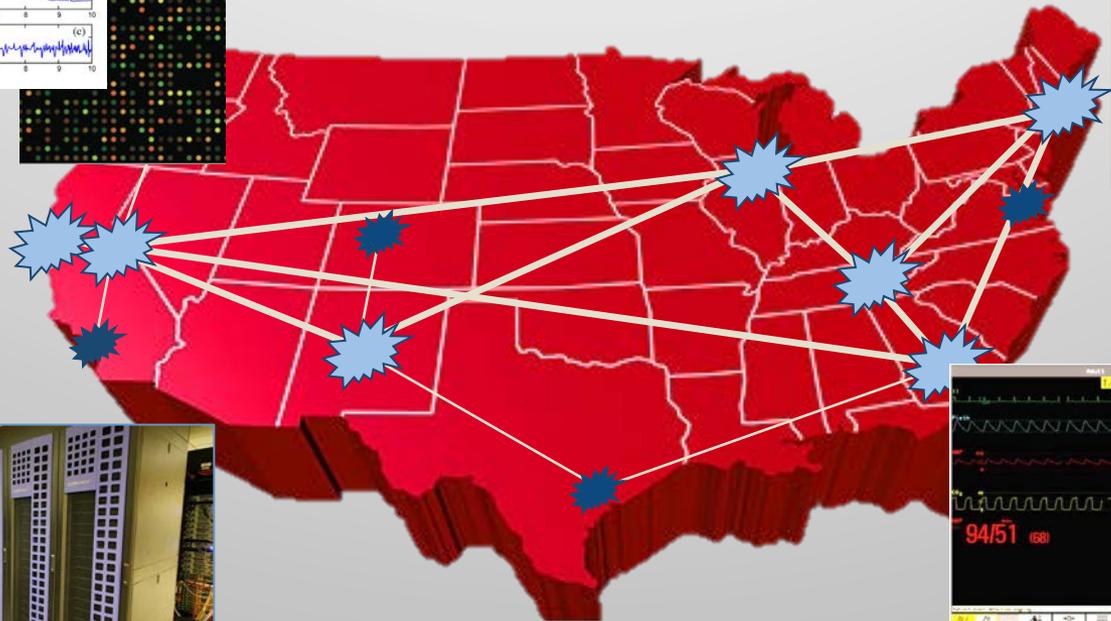


Collaboration: To succeed we need a consortium of partners linked in a shared data and computing ecosystem

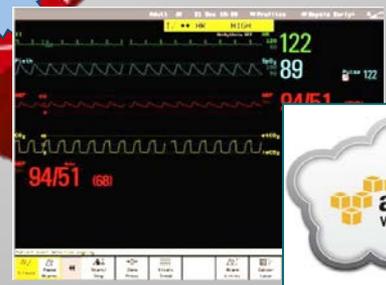
Shared dataspace in the cloud



Development of targeted sensors



HPC for multi-scale modeling and analytics R&D



Hyper-scale web services for clinical delivery

A Concrete scientific programmatic plan toward predictive biology

Scientific programs	Predictive pharmacology	Predictive pathophysiology	Predictive pathogen biology	Predictive physiology
Use case	<i>In silico</i> prediction of PK/PD ¹ and toxicity of drugs	Predictive model of immunologic response in critical care	Predicting the microbiome response to critical illness	Dynamical model of gene regulatory network (GRN) for cancer
Motivation / benefit	<ul style="list-style-type: none"> • Increase drug R&D efficiency • Prevent adverse drug reactions 	<ul style="list-style-type: none"> • Effective critical care mitigate the lack of specific drugs • Growing challenge 	<ul style="list-style-type: none"> • Microbiome is affected by antibiotics and makes important contributions to 	<ul style="list-style-type: none"> • Understand gene regulatory dynamics in cancer • Identify novel targets for drugs
Ultimate goal	<i>High-throughput in silico prediction of adverse (and beneficial) effects of drugs</i>	<i>Real-time recommendation of personalized critical care treatment</i>	<i>Predicting the influence of the microbiome on critical illness to guide therapy</i>	<i>Novel cancer therapy targeting key gene networks instead of single mutated genes</i>
Partners	 Joe Loscalzo MD, PhD	 Tim Buchman MD, PhD	 Gary An, MD	

1. PD/PK = Pharmacodynamics and pharmacokinetics 2. Abbreviated as XDR-TB

Why now?

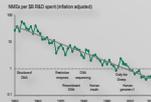
There is both the need and the means

There are pressing crises in biology impacting US and beyond...



Continual rise of antimicrobial resistance, Enterovirus D68, and Ebola virus

- Decreasing pharmaceutical productivity



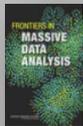
Drug R&D at or below cost of capital

- Combined with rising cost of bringing new drugs to market



Emerging and engineered pathogens pose unprecedented asymmetric threats

- Democratization of biology
- Continued life sciences advancements



Digital revolution has missed the biomedical sector

- Advances in other sectors are computational driven

...and advances that allow us to address them

Biology

Million-fold decrease in genetic sequencing cost

- Allow association studies linking genetics to disease
- Personalized therapy based on individual genetics within reach

Massive clinical data explosion

- Need to marry disparate data sets with new computational tools

Computation

Exponential growth in high-performance computational power

- Growth globally, not just US

Rise and commercial-based Cloud compute services

- Continual innovation allow democratization of advanced computing capabilities

