DOE JGI: Strategic Planning for the Genomic Sciences Workshop Report

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DOE JGI: Strategic Planning for the Genomic Sciences Workshop Report

May 30-31, 2012 Washington DC

Co-chairs:
Jim Fredrickson (PNNL)
Jan Leach (Colorado State)
Michael Laub (MIT)

Breakout Chairs:
Kimmen Sjolander (UC Berkeley),
Tom Schmidt (Michigan State)
Richard Michelmore (UC Davis)

Speakers:
Greg Petsko (Brandeis)
Maureen McCann (Purdue)
Claire Fraser (U Md)
John Gerlt (UIUC)
DOE JGI Sequencing Economies of Scale

$0.90 (Sanger)

$0.00005 (Illumina HiSeq)

Year

2007 2008 2009 2010 2011 2012

Bases Sequenced (Gigabases)

$ per 1,000 bases

0 0.5 1

Sanger 454 Illumina
Rate of Sequencing Outpaces Moore’s Law

- DNA sequencing: Bases/$100
- Gene synthesis: Bases/$7,250
- Moore's Law (transistor density/chip)
Motivation for the Workshop

- A need to solicit broad community ideas, input, and support for what a next-generation genome center (the DOE-JGI) should evolve into, and the challenges it should be able to address, to remain current and necessary.

- Given that sequencing technologies have advanced so rapidly, how might this affect the scientific scope at the DOE-JGI and its ability to stay at the forefront of exploiting these changes.

- Connection to BER mission needs be articulated carefully and clearly.
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Initial Assumptions:

1) DOE-JGI will remain an Office of Science User Facility

2) DOE-JGI will continue to generate BER-mission relevant sequence in large amounts and high quality

3) DOE-JGI can’t do everything, it must be strategic in what capabilities it develops and how it transitions to a next-generation genome science center

4) Rather than “reinventing the wheel”, DOE-JGI should avail itself of other DOE assets where appropriate (e.g. Kbase, EMSL, etc.)
# DOE JGI: Strategic Planning for the Genomic Sciences Workshop Report:
## Participants

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<tr>
<th>Name</th>
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<td>Blake Simmons</td>
<td>JBEI/SNL</td>
<td>Shawn Kaeppler</td>
<td>GLBRC/U Wisc</td>
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<td>Gary Stacey</td>
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<td>Tom Schmidt</td>
<td>(MSU)</td>
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Workshop Charge:

- What new scientific insights could be enabled by next-generation sequencing? What vision for DOE mission-driven biology, rooted in and building on high-throughput genomic sequencing and analysis, can be identified for the next 5 to 10 years?

- What large-scale questions/grand challenges in systems biology, grounded in very high-throughput genomics and post-genomic analyses, will require a user facility to achieve necessary efficiencies and effectiveness and would have the highest impact and value for DOE biology?

- What capabilities and technologies that do not presently exist, presently lack high-throughput capability, or are not generally available to the biological research community, will be required to address the most important questions in biology and to meet the needs of DOE biological science?
DOE JGI: Strategic Planning for the Genomic Sciences Workshop Report: Areas of Focus (1)

1. Continued and increasing large-scale sequencing of biologically important organisms and communities.

2. Large-scale functional genomics technologies for high-throughput functional annotation, informed by global measurements of actual cellular activities rooted in genome sequencing.

3. Extended and improved bioinformatics methods to enable integration and analysis of unprecedented quantities of data and to generate testable hypotheses critical to advancing DOE science
4. **Aggressively expanded capacity not only to sequence (“read”) DNA, but also to synthesize (“write”) DNA, enabling scientists to manipulate genomes.**

5. **Improved automation of biological experiments to match the throughput now prevalent in sequencing.**

6. **Communities of scientists led by the DOE-JGI and organized around key mission-relevant scientific questions.**
Vision for the DOE-JGI: Hypothesis-Generating and Validation Engine for Fundamental Systems Biology
Toward a More Systematic Annotation Pathway

**Draft genome (assembly and structural annotation)**

- **Scientific knowledge and understanding**
  - Examination of predicted functions and experimental data; feedback to bioinformatics methods for functional annotation (learn from mistakes and successes)

- **Bioinformatics methods for automating functional annotation** (e.g., ortholog identification, biochemical pathway, phenotype, cellular localization, interactions, and structure)

- **Comparative genomics and ortholog identification** to flag assembly and/or gene model errors

- **Experimental determination of "function"**; functional assays may be prioritized based on predicted functions or by high-throughput screening

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[Logo: DOE Joint Genome Institute and Research Community]

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DOE JGI: Strategic Planning for the Genomic Sciences Workshop Report: Exemplar Science Challenges

1) Designer Phototrophs: Engineering Cyanobacteria to Produce Biofuels

2) Understanding Interactions Between Microbes and Climate

3) Advanced Genomic Capabilities for Biofuel Sustainability

4) Mining Natural Variation to Improve Energy Capture (Photosynthesis) in Plants

5) Dynamics of Genomic Participation in CO$_2$ Cycling in Marine Environments

6) Characterizing Horizontal Gene Transfer (HGT)
1) Promote Emerging Technologies Opportunity Program (ETOP) at DOE-JGI Posted 10-5-12
http://www.jgi.doe.gov/programs/ETOP/index.html

2) Tune the Community Sequencing Program at DOE-JGI towards challenges identified by the workshop

3) Continue to work closely with BRCs, Kbase, other sophisticated users to push the state of the art in next-generation genome analyses and annotation

4) Continue to develop new sequencing technology(ies) as a faster-better-cheaper “hypothesis-generation engine”
5) Promote and encourage the development of complementary interactions with other DOE facilities and activities

6) Continue to explore opportunities for the application of high-performance computation to genome analyses

7) Build on emerging DNA synthesis capabilities to test annotations and enable biosystems design science

8) Continue to “seed” DOE-mission-focused communities of scientists to accelerate use of DOE-JGI generated sequence
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• Report: Posted September 27, 2012

• URL:  
  http://genomicscience.energy.gov/userfacilities/jgi/futuredirections/DOE-JGI-StrategicPlanningWkshp.pdf

• Report is in your packets, Executive Summary is on Joanne’s table.

• DOE-JGI 10-Year Strategic Vision:  
  http://www.jgi.doe.gov/whoweare/10-Year-JGI-Strategic-Vision.pdf

• Strategic Plan (posted September 27) is in your packets.
Thank you
JGI Emerging Technologies Opportunity Program (ETOP)

• The overall objective of the ETOP is to support new and existing DOE JGI partners to develop promising projects focused on new technical capabilities that could be provided to users. Consistent with strategic vision plan, ETOP encourages projects to develop:
  – high-throughput functional genomic capabilities
  – microfluidic molecular biology approaches
  – New ways to isolate high quality DNA and RNA from fungi, microbes and plants
  – functional characterization of microbes and microbial communities, including non-destructive functional characterization of single cells
  – large scale microbial phenotyping

• Beginning in FY13, the DOE JGI anticipates making available up to $1.5 million per year for the program through the funding of 3-5 projects for up to three years.

• Pre-proposals need to be received by December 15, 2012.

• Invitations to submit full proposals will be communicated to the applicants by January 25, 2013.

• Full proposals must be submitted by February 20, 2013.