THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Board on Chemical Sciences and Technology

Final Report

Award No. DOE-6266

Research Frontiers in Bioinspired Energy: Molecular-Level Learning from Natural Systems: A Workshop

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For Period September 1, 2009 – December 31, 2011

Board on Chemical Sciences and Technology
Committee on Research Frontiers in Bioinspired Energy: Molecular-level Learning from Natural Systems (a Workshop)

PROJECT AND ACTIVITIES

An interactive, multidisciplinary, public workshop, organized by a group of experts in biochemistry, biophysics, chemical and biomolecular engineering, chemistry, microbial metabolism, and protein structure and function, was held on January 6-7, 2011 in Washington, DC. Fundamental insights into the biological energy capture, storage, and transformation processes provided by speakers was featured in this workshop—which included topics such as microbes living in extreme environments such as hydrothermal vents or caustic soda lakes (extremophiles)—provided a fascinating basis for discussing the exploration and development of new energy systems. Breakout sessions and extended discussions among the multidisciplinary groups of participants in the workshop fostered information sharing and possible collaborations on future bioinspired research. Printed and web-based materials that summarize the committee's assessment of what transpired at the workshop were prepared to advance further understanding of fundamental chemical properties of biological systems within and between the disciplines. In addition, web-based materials (including two animated videos) were developed to make the workshop content more accessible to a broad audience of students and researchers working across disciplinary boundaries. Key workshop discussion topics included:

Exploring and identifying novel organisms

Workshop participants discussed the enormous amount of biological diversity that is completely untapped and needs to be explored. For example, through exploring unique redox environments in the ocean, speaker Rolf Thauer and others discovered new organisms capable of anaerobic oxidation of methane, which are now being explored for bioenergy applications.

Identifying patterns and conserved biological structures in nature

Given the diversity of energy solutions in biology, there is also a need to look for patterns, conserved structure, and functionality across biological systems for inspiration. For example, through his extensive studies of electron transfer proteins, Les Dutton discussed the possibility of using rational design to create synthetic electron transfer proteins, which would serve as components of future synthetic biology systems.

Exploring and identifying fundamental properties and mechanisms of known biological systems

Understanding biological systems at the most fundamental level may make it be possible to redesign and create better systems. If the fundamental process the nitrogen fixing enzyme nitrogenase were understood better, it might be possible to design an artificial enzyme for large-scale applications, which could significantly reduce energy use.

Supporting current, and creating new, opportunities for interdisciplinary education, training, and outreach

A successful NASA funded course on Planetary Biology and Microbial Ecology was highlighted, as well as a current DOE-NAS supported microbial ecology summer school.[1]

Applying knowledge from biology to create new devices and sustainable technology

There was a lot of interest in further exploration and application of the recently discovered bacterial nanowires (in *Shewanella* based on talk by Ken Nealson)[2] as a basis for alternative electron transfer architectures for energy, water purification, and other applications.

The published workshop report is available at:
http://books.nap.edu/catalog.php?record_id=13258

Workshop speaker presentations and other special features are available at: http://nas-sties.org/bioinspired/ (Note: The official launch of this website will be in April 2012.)

[1] Microbial Diversity Summer Course at Woods Hole:
http://www.mbl.edu/education/courses/summer/course_micro_div.html
http://courses.mbl.edu/microbialdiversity/index.html

[2] Gorby et al. Electrically conductive bacterial nanowires produced by Shewanella oneidensis strain MR-1 and other microorganisms. 2006. PNAS 103(30): 11358-11363; http://www.pnas.org/content/103/30/11358.long.