Biomimetic or Bioinspired?

I read a fascinating article the other day, "From Biomimesis to Bioinspiration: What's the Benefit for Solar Energy Conversion Applications?" by Valentine Ivanov Vullev [*J. Phys. Chem. Lett.*, **2**, 503 (2011)]. While this article provides perspectives within the relatively narrow and specialized context of harnessing solar energy, it got me thinking about the much broader implications of some of the ideas put forth by the author. A key point made by the author is the progression from biomimicry to biomimesis, and ultimately to bioinspiration. To quote from the author, "While biomimetics play a crucial role in exploratory research and in basic science, their technological implementations are somewhat limited. …. Going beyond what Nature provides usually entails a number of transitions, (1) from biomimicry, which involves solely superficial imitation of the biological systems, (2) to biomimetics, which attempts to copy and recreate the structure-function relations observed in living entities, and finally (3) to bioinspiration, through which structural propertied and functionality are pushed to new levels, beyond what Nature offers." For example, flying airplanes was an idea hatched by watching birds in flight; think of the movie "*Those Magnificent Men in Their Flying Machines*," the 1965 British comedy film that is forever etched in my memory since childhood. Particularly hilarious in this movie were scenes of men test-piloting the many rudimentary machines and crashing them to the ground. These early aircraft versions were but a very crude (bio)mimicry of the amazing natural machinery inherent in the wings and muscles of birds. However even the most skeptic among us would have to agree that we have now surpassed Nature in designing powerful aircraft (and spacecraft) that can fly much longer, higher, and faster than birds. This example illustrates the "transitions" that Vullev is talking about in his article, although one can equally well argue that engineers short-circuited the progression by the invention of jet engines.

Photosynthesis provides another test bed for the above paradigms. Plants and algae have evolved over millennia in the intricate assembly of architectures and electron transfer pathways that enable them to convert CO_2 and water to biofuels that sustain them. Yet it is worth noting that these biological systems are not very efficient in converting solar photons to fuels. Unlike the aviation example above, however, scientists are only now beginning to understand how these intricate living systems work by constructing and studying artificial models (the biomimetic stage in the progression). In the next stage, hopefully, those of us engaged in energy conversion R&D will be around to witness a bioengineered photosynthetic system with performance superior to its natural counterpart.

Yet another example requiring some progress before we can surpass Nature concerns the design and study of robust bioelectrochemical systems for dioxygen reduction. Recall that this reaction has implications for fuel cells for converting chemical to electrical energy and constitutes the kinetic bottleneck in the overall energy conversion pathway. Specifically electrochemical scientists and engineers (including many within our Society) have carved out distinguished careers in developing efficient catalysts for driving the 4-electron reaction. Notwithstanding substantial progress in this field, the need for Pt and other noble metal catalysts remains a daunting technological barrier to commercialization of this type of fuel cells. On the other hand, Nature accomplishes this task with enzymes that have precisely tuned architectures and redox environments to facilitate the catalytic process without the need for Pt or noble metals!

This special issue focuses on materials that are close to my own research interests, namely, conducting polymers (CPs). As the guest editors of this issue point out in their preface, the sustained and dedicated efforts of generations of scientists in gaining fundamental understanding of how the polymer chemical architecture, morphology (specifically defects), and electrical conductivity are intertwined have now opened the door to practical applications. Some of the most intriguing of these applications lie in the biomedical arena. For example CPs are being considered for nerve regeneration, "smart" skin, and artificial muscle development. Are these endeavors biomimetic or bioinspired? Only time will tell. Stay tuned.

Raj K.

Krishnan Rajeshwar
Editor

The Electrochemical Society
INTERFACE

Published by:
The Electrochemical Society (ECS)
65 South Main Street
Pennington, NJ 08534-2839, USA
Tel 609.737.1902
Fax 609.737.2743
www.electrochem.org

Canada Post:
Publications Mail Agreement #40612608
Canada Returns to be sent to:
Pitney Bowes International, P.O. Box 25542,
London, ON N6C 6B2

ISSN
Print: 1064-8208
Online: 1944-8783

The Electrochemical Society Interface is published quarterly by The Electrochemical Society (ECS), at 65 South Main Street, Pennington, NJ 08534-2839 USA. Subscription to members as part of membership service; subscription to nonmembers is available; see the ECS website. Single copies $9.00 to members; $17.00 to nonmembers. © Copyright 2012 by The Electrochemical Society. Periodicals postage paid at Pennington, New Jersey, and at additional mailing offices. POSTMASTER: Send address changes to The Electrochemical Society, 65 South Main Street, Pennington, NJ 08534-2839.

The Electrochemical Society is an educational, nonprofit 501(c)(3) organization with more than 8000 scientists and engineers in over 70 countries worldwide who hold individual membership. Founded in 1902, the Society has a long tradition in advancing the theory and practice of electrochemical and solid-state science by dissemination of information through its publications and international meetings.

PRINTED WITH SOY INK

All recycled paper. Printed in USA.