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BOOK REVIEW

Matthias Rögner (ed): Biohydrogen

Walter de Gruyter GmbH, Berlin/Munich/Boston, 2015, ISBN 978-3-11-033645-0

Govindjee[1]

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The title of this book *"Biohydrogen"* really means hydrogen evolution from biological organisms, usually algae and cyanobacteria. Before I begin this book review, I would like all of us to remember Hans Gaffron (May 17, 1902–August 18, 1979) who is the discoverer of hydrogen evolution from green algae, using light, and electrons derived ultimately from water (see e.g., Homann 2005). This current book on *Biohydrogen* is very timely since we are in urgent need to prepare ourselves against future disaster facing our world: increasing population, global warming, and predicted reduction in fossil energy and biomass available for our needs. I certainly hope that bioenergy will eventually replace fossil energy. Around our world, there is a multipronged attack on this problem of global concern by the entire scientific community that includes physicists, chemists, biologists, engineers, and computer scientists. Among the many solutions to our problem, *Biohydrogen* is the most promising future energy carrier. This book provides an authoritative discussion on the current status of *Biohydrogen* research and points the readers toward the real future. There is an emphasis in this book on both biology and chemistry, but also on materials science, chemical engineering, and even industrial chemistry to some extent. Thus, it is a very important resource for the entire scientific community and all the libraries of the world.

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Biohydrogen was edited by one of the leading authorities in the field, Matthias Rögner, of Ruhr University, in Bochum, Germany; the book is exceptionally rich in its content and contains in depth discussion on all aspects of *Biohydrogen*, all packed very effectively in 275 pages, and in 12 chapters. A 7-page index is very useful indeed in finding topics of interest covered in this book. It is authored by 29 well-known scientists: most (20) of the authors are from Germany, 5 are from the USA, 2 from Japan, and 2 from Sweden. The book appropriately focuses on *Biohydrogen* research being done on cyanobacteria and green algae around the globe, not only in the countries where the authors are from; thus, it is truly an international book.

Figure 1 is a reproduction of the nice cover of this book.

The best way to get a good idea of the content of this book is to see the topics from the titles of the 12 chapters. They are Chapter **1** (Cyanobacterial design cell for the production of hydrogen from water); Chapter **2** (Analysis and assessment of current photobioreactor systems for photobiological hydrogen production); Chapter **3** (Catalytic properties and maturation of [FeFe]-hydrogenases); Chapter **4** (Oxygen-tolerant hydrogenases and their biotechnological potential); Chapter **5** (Metal centers in hydrogenase enzymes studied by X-ray spectroscopy); Chapter **6** (Structure and function of [Fe]-hydrogenase and biosynthesis of the FeGP Cofactor); Chapter **7** (Hydrogenase evolution and function in eukaryotic algae); Chapter **8** (Engineering of cyanobacteria for increased hydrogen production); Chapter **9** (Semi-artificial photosynthetic Z-scheme for hydrogen production from water); Chapter **10** (Photosynthesis and hydrogen metabolism revisited; on the potential of light-driven hydrogen production in vitro, Chapter **11** (Re-routing redox chains for directed photocatalysis); and Chapter **12** (Energy and entropy engineering

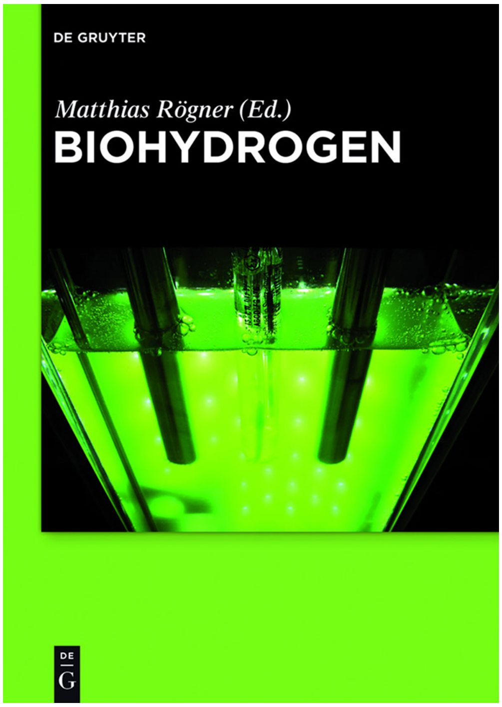

Fig. 1 A photograph of the cover of the *Biohydrogen* book

on sunlight conversion to hydrogen using photosynthetic bacteria).

I would like to emphasize that three basic problems haunting us in the field of *Biohydrogen* have been (i) oxygen sensitivity of the enzyme hydrogenase; (ii) difficulties in the design of coupling electrons from photosystem I (PSI) to the hydrogen-producing system; and (iii) low efficiency of hydrogen production. Practical solutions to these problems by various strategies have been discussed in many chapters in this book. As an example, chapter 1 provides information on how (a) reduction in the size of the antenna; (b) partial uncoupling of ATP synthesis; (c) redirecting electron flow from PSI acceptor side to the hydrogen-producing system; (d) different design of the hydrogenases; and (e) continuous cultivation of algae and cyanobacteria—among other measures—can improve our ability to use *Biohydrogen* to better our future lives.

Figure 2 summarizes wonderfully well the major design steps needed to use water to produce hydrogen for our use.

All fair book reviews are required to mention the weaknesses in the book. It is not easy for me to present any real weakness except maybe to point out that there are some minor typographical errors. For example, on page 8, "Fig. 6c" should have been printed as "Fig. 1.6c"; and more importantly, "Calvin cycle" should have been listed as "Calvin-Benson cycle." Personally, I would have liked to see a citation to Govindjee and Björn (2012) on the evolution of the Z-scheme in chapter 9. And, of course, I would like to bring to the attention of the readers of my book review to also look carefully at another recent book "Microbial Bioenergy: Hydrogen Production" (Zannoni and De Phillipis 2014). Further, I encourage the readers to consult all the 40 volumes in the Series (*Advances in Photosynthesis and Respiration Including Bioenergy and Other Processes,* published by Springer, Dordrecht, The Netherlands; series editors: Govindjee and T. Sharkey) because they deal with topics that are highly relevant to the topic of the current book (see <http://http://www.springer.com/series/5599>).

I end this review with a recommendation to all the laboratories doing *Biohydrogen* research to acquire a copy of this wonderful and highly authoritative book for all their students and staff. Further, I also recommend this book to all the libraries at all the Universities and all Research Institutes around this world that they acquire a copy of this book (hardcopy or a e-book) for their teachers as well as their graduate and post-graduate students in all areas of Science and Engineering.

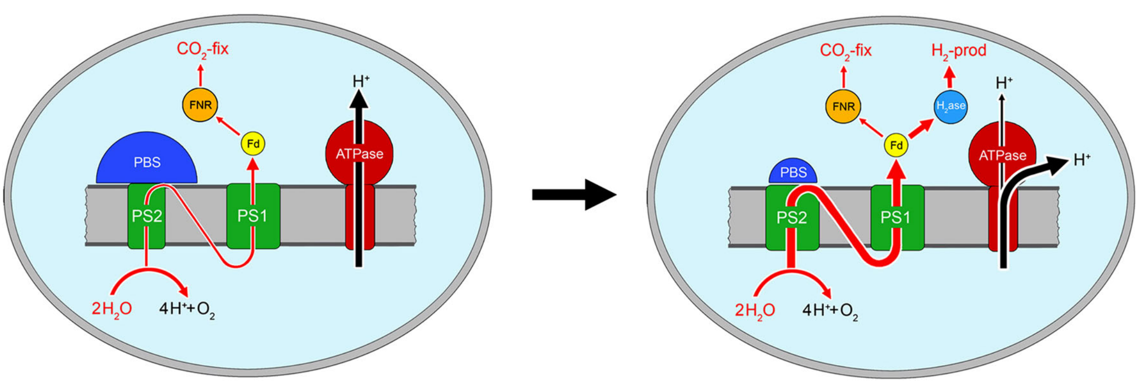

Fig. 2 A summary of the major design steps for the transformation of a cyanobacterial Wild-Type cell (*left*) into a design of a cell which would efficiently produce hydrogen from water (*right*). Source: Fig. 1.12 in Chapter 1 of Rögner (2015). Reproduced with permission

Acknowledgments I thank Tom Sharkey for reading this *book review* before it was submitted to *Photosynthesis Research* for publication. I am grateful to Matthias Rögner for providing me the two figures used here and to Silke Hutt for sending me permission, by e-mail, to reproduce Fig. 2.

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