Biochimica et Biophysica Acta 1837 (2014) 1377–1383

Contents lists available at ScienceDirect

Biochimica et Biophysica Acta

journal homepage: www.elsevier.com/locate/bbabio

Editorial

Photosynthesis research for sustainability: Keys to produce clean energy

Oxygenic photosynthesis powers life on earth by providing oxygen and energy in the form of organic substances. The ultimate source of energy is sunlight, and that of oxygen is water, two virtually unlimited resources available on the Earth. It is the advent of oxygenic photosynthesis some 2.7 billion years ago by the ancestors of cyanobacteria that transformed the whole environment on earth from an anaerobic one to an oxygenic one, leading to an unprecedented explosion in biological activity, and allowed life to prosper and diversify on an enormous scale, as witnessed by the fossil records and by the extent and diversity of living organisms on our planet today. Photosynthesis is still, and will remain to be, the most important biological process on the Earth, in terms of providing energy, and maintaining the environment indispensible for oxygenic life. In fact, two major issues that we face today, or in the near future, are short of energy supply and the environmental problems, and solutions to these issues are closely related with photosynthesis. The energy stored in petroleum, natural gas and coal all ultimately come from the sun as a result of consuming carbon dioxide via photosynthesis, as does the energy in firewood and other organic materials, which are major fuels in many parts of the world. If we are to fulfill our energy supply continuously and sufficiently, and to reduce the emission of carbon dioxide remarkably, we must learn from photosynthesis on how to obtain energy from the sun artificially and efficiently. Thus, studies on the mechanism of photosynthesis have remained for several decades, and are still, one of the central topics in the field of biology in general and in the area of bioenergetics in particular. (See Figs. 1– 9.)

Owing to the considerable complexity of the proteins and reactions involved in photosynthesis, a range of modern techniques including biochemistry, biophysics, molecular biology, structural biology, and theoretical chemistry has been employed in revealing the secret of photosynthesis. As a result of the extensive studies carried out, the architecture of most of the protein complexes involved in light-energy harvesting, water-splitting, electron transport, etc., have been elucidated. A notable example is the recent determination of crystal structure of photosystem II at a 1.9 Å resolution [1], which not only provided the basis to uncover the mystery of light-induced water oxidation that is important for artificial photosynthesis, but also moved the limit of resolution for the structure of large membrane–protein complexes like photosystem II to an atomic level, making the reactions catalyzed by such huge complexes to be described on a solid chemical basis. Meanwhile, there are many questions that remained beyond the structures, and one important feature of the photosynthetic organisms is their diversity, among which, only the photosynthetic apparatus from a limited sources of organisms is investigated. Clearly, there are even more investigations needed in order for us to fully understand the photosynthetic apparatus and reactions, as well as their diversities in a range of organisms.

In order to bring scientists from all over the world together to discuss the state-of-the-art studies on light-induced reactions of photosynthesis in a diverse range of organisms, a conference "Photosynthesis Research for Sustainability—2013 in honor of Jalal A. Aliyev" was held in Baku, Azerbaijan, during June 5–9, 2013, which followed an earlier conference held in 2011. It was a great pleasure for the hosts to welcome nearly 350 participants from 32 countries in Baku (the capital city of the Azerbaijan Republic). This special issue of BBA-Bioenergetics is a collection of papers contributed from invited authors who attended the 2013 conference, which highlighted most recent advances of our understanding on the studies of various aspects of light-induced photosynthetic reactions including the absorption of light-energy, their transfer, light-induced charge separation and electron transfer, and water-oxidation, in a range of diverse organisms. The readers will find most updated information on this field of photosynthesis research.

As the organizers of the Baku international conference, we would like to express our gratitude to all the speakers, chairs, and poster presenters for their great participation during the congress. We especially thank the International and local scientific committees, for their fantastic work and great support. For the record and information of the Baku conference, we present here some snapshots taken at the conference (Figs. 1– 9).

Acknowledgments

We express our sincere appreciation to all authors, from different countries, who contributed papers for this special issue, and also to our many dedicated, hard-working reviewers. We are especially grateful to Fabrice Rappaport and Susanne Arnold Executive Editors of BBABIO, and the following at Elsevier, Andy Deelen and Zophos for their advice in developing this exciting issue, and for their constant support. SIA, acknowledges the Russian Foundation for Basic Research, and the Molecular and Cell Biology Programs of the Russian Academy of Sciences.

Reference

[1] Y. Umena, K. Kawakami, J.R. Shen, N. Kamiya, Crystal structure of oxygen-evolving photosystem II at a resolution of 1.9 Å, Nature 473 (2011) 55–60.

http://dx.doi.org/10.1016/j.bbabio.2014.07.002
0005-2728/

Dr. Suleyman I. Allakhverdiev is the head of the Laboratory of "Controlled Photobiosynthesis" at the Institute of Plant Physiology Russian Academy of Sciences (RAS), Moscow, and Chief Research Scientist at the Institute of Basic Biological Problems RAS, Pushchino, Moscow Region, Russia. He obtained his Dr. Sci. degree (highest/top degree in science) in plant physiology and photobiochemistry from the Institute of Plant Physiology RAS (2002, Moscow), and Ph.D. in physics and mathematics (biophysics), from the Institute of Biophysics USSR (1984, Pushchino). Earlier, he had graduated with a B.S./M.S., in physics from the Department of Physics, Azerbaijan State University, Baku.

He worked for many years (1994–2007) as visiting scientist at the National Institute for Basic Biology (with Prof. Norio Murata), Okazaki, Japan and in the Department de Chimie-Biologie, Université du Quebec à Trois Rivières (with Prof. Robert Carpentier), Quebec, Canada (1989–1991). He has been the guest editor of many (above 20) special issues in international peer-reviewed journals, as well as, currently a member of the Editorial Board of more than 10 international journals. Besides being editor-in chief of SOAJ NanoPhotoBioSciences and associate editor of the International Journal of Hydrogen Energy, he also acts as a referee for major international journals and grant proposals. He has authored (or co-authored) more than 300 papers. He has organized several international conferences on photosynthesis. His research interests include the structure and function of photosystem II, water-oxidizing complex, artificial photosynthesis, hydrogen photoproduction, catalytic conversion of solar energy, plant under environmental stresses, and photoreceptor signaling.

Dr. Jian-Ren Shen is a professor and director of Photosynthesis Research Center, Graduate School of Natural Science and Technology, Okayama University in Japan. He received his bachelor's degree in Biology from Zhejiang Agricultural University (now Zhejiang University) in China in 1982 and gained his Ph.D. in Biochemistry from the University of Tokyo in 1990. He subsequently spent 13 years in RIKEN (The Institute of Physical and Chemical Research) in Japan with the group of Yorinao Inoue studying the structure and function of photosystem II, and moved to Okayama University as a Professor in 2003, where he is continuing studies on the mechanism of photosynthetic water oxidation based on structural analysis of photosystem II. In collaboration with his colleagues, he solved the structure of photosystem II at 1.9 Å in 2011, which was selected as one of the "Breakthrough of the Year 2011" by the journal Science. His research interests include the structure and function of photosystem II, water-oxidizing complex, catalytic conversion of solar energy, high-resolution crystal structural analysis of membrane proteins and their complexes.

Suleyman I. Allakhverdiev
Institute of Plant Physiology, Russian Academy of Sciences, Botanicheskaya Street 35, Moscow 127276, Russia
Institute of Basic Biological Problems, Russian Academy of Sciences, Pushchino, Moscow Region 142290, Russia
E-mail address: suleyman.allakhverdiev@gmail.com.

Jian-Ren Shen
Graduate School of Natural Science and Technology/Faculty of Science, Photosynthesis Research Centre, Okayama University, Okayama 700-8530, Japan
E-mail address: shen@cc.okayama-u.ac.jp.

Fig. 1. *Left to right*: Jalal A. Aliyev and Ali Abbasov (Conference co-chair from Azerbaijan, and Minister of Communication and Information Technology of the Azerbaijan Republic), *before opening ceremony*.

Fig. 2. Opening ceremony of the conference "Photosynthesis Research for Sustainability-2013: in honor of Jalal A. Aliyev. Place: Azerbaijan State Musical Theatre. *Left to right*: Ali Abbasov (Conference co-chair from Azerbaijan, and Minister of Communication and Information Technology of the Azerbaijan Republic) *at the podium*, Suleyman Allakhverdiev (Coordinator of the conference), Jalal A. Aliyev (Honorary chairman, Azerbaijan), John Walker (Nobel Prize in Chemistry 1997, UK), and Bruce Osborne (Co-chair of conference, and President of Federation of European Societies of Plant Biology (FESPB), UK).

Fig. 3. Some of speakers at opening ceremony: *Top*, *left to right*: John Walker (Nobel Prize in Chemistry 1997, UK), Hiroshi Nishihara (Japan), Bruce Osborne (Co-chair of conference, and President of Federation of European Societies of Plant Biology (FESPB), UK), Les Dutton (USA); *Bottom*, *left to right*: Norio Murata (Japan), Eva-Mari Aro (Finland), Akif Alizadeh (President of Azerbaijan National Academy of Sciences), Ahliman Amiraslanov (Academician Secretary of the Department of Biological and Medical Sciences, Azerbaijan National Academy of Sciences).

Fig. 4. The audience in the State Musical Theatre Hall at the opening ceremony.

Fig. 5. *Top*, *left to right*: Norio Murata (Japan), Seiji Akimoto (Japan), Yashar Feyziyev (Azerbaijan), Tatsuya Tomo (Japan), Karim G. Gasimov (Azerbaijan), Kentaro Ifuku (Japan), Tohru Tsuchiya (Japan). Gyözö Garab (Hungary), Ernst-Walter Knapp (Germany), Nathan Nelson (Israel), Jean-David Rochaix (Switzerland), Arvi Freiberg (Estonia), Agu Laisk (Estonia). *Bottom*, *left to right:* Irada Huseynova (Azerbaijan), John Walker (Nobel Prize in Chemistry 1997, UK) with Suleyman Allakhverdiev (Russia), Atefeh Nemati Moghaddam (Iran).

Fig. 6. *Top*, *left to right*: Jalal A. Aliyev and Irada Huseynova (Azerbaijan); Young Investigator award, *right to left*: Tatsuya Tomo (Japan), Govindjee (who presented award, USA), Suleyman I. Allakhverdiev (Russia), Stefan Köller (Winner, Germany), Eva-Mari Aro (Finland), Gyözö Garab (Hungary). *Bottom*; *left to right*: Jian-Ren Shen (Japan), Fusamichi Akita (Japan), Yoshiki Nakajima (Japan), Suleyman Allakhverdiev (Russia), Natsumi Ugai (Japan), Tatsuya Tomo (Japan), Kyoko Okuzono (Japan), Miyachi Mariko (Japan).

Fig. 7. Group photographs of many of the participants during the tour to Gobustan Rock Art Cultural Landscape-Gobustan National Park.

Fig. 8. Photographs of smaller groups/participants of the conference visiting wheat field where the research of Jalal A. Aliyev and his coworkers is in action.

Fig. 9. Govindjee expressing thanks, on behalf of all the international participants, to Jalal Aliyev.