Preface

> **Jules Verne (1828–1905) wrote in 1874:** *"Water will one day be employed as fuel—the hydrogen and oxygen that constitute it, used singly or together, will furnish an inexhaustible source of heat and light".*

Why should we focus on Photosynthesis, which, by using sunlight, becomes an *inexhaustible source* of energy for the planet? We hope that our book "**Photosynthesis: Solar energy for life**" will answer that for you. Photosynthesis is the most central and the most important process on the Earth, providing "order" from "disorder" using the all-abundant sunlight. Each year, photosynthesis fixes about 100 gigatons of carbon, supporting all life on our Planet, by providing us with oxygen to breathe and food to survive.

Our understanding of photosynthesis can now be said to have reached encyclopedic dimensions; there have been, in the past, many good books at various levels (Appendix A[1]). Our book is intended to fulfill the needs of undergraduate and beginning graduate students in all branches of biology as well as biochemistry, biophysics, and bioengineering. Photosynthesis will be central to future advances in producing more

[1] **Appendix A**

During 1945–1956, Eugene Rabinowitch (1898–1973), a post-doc student of the 1926 Nobel laureate, James Franck (1882–1964), wrote a 2088 page book in three physical volumes (Vol. I [1945], Vol. II [1951], Part 1, and Vol., Part 2 [1956]). It was indeed like a "Bible" of this field (available free at http://www.life.illinois.edu/govindjee/g/Books.html) at that time. If we were to write a similar book (almost impossible for most of us), it will take at least 30,000 pages! For college and university students, books by the following authors are worth mentioning: Robert Blankenship (*Molecular Mechanisms of Photosynthesis*, 2nd ed., 2014), Paul G. Falkowski & John A. Raven (*Aquatic Photosynthesis*, 2nd ed., 2007), Bacon Ke (*Photosynthesis*, 2003), David W. Lawlor (*Photosynthesis*, 2001), Eugene Rabinowitch & Govindjee (*Photosynthesis*, 1969; available free at http://www.life.illinois.edu/govindjee/g/Books.html.), and David Hall & Krishna K. Rao (*Photosynthesis*, 1967–1999). For advanced graduate and doctoral students, there are indeed many edited books by, e.g., Govindjee (*Bioenergetics*, 1975), Achim Trebst and Mordhay Avron (*Encyclopedia of Plant Physiology*, 1976), several volumes in "Topics in Photosynthesis", edited by James Barber (1976–1992), and more than 40 volumes in "Advances in Photosynthesis and Respiration" since 1994 (Govindjee and Thomas Sharkey, series editors; now Sharkey and Julian Eaton-Rye; see: http://www.springer.com/series/5599?detailsPage=titles).

food, more biomass, more fuel, and new chemicals for the expanding global human population. Further, the fundamentals of natural photosynthesis will provide the necessary information to engineer artificial photosynthesis, an important emerging field where chemists and engineers will play a major role.

Our book is presented in nine chapters arranged in a systematic pedagogical style with references so that the readers have an open-ended field before them. **Chapter 1** is an introduction explaining the "Why" of photosynthesis; in addition, it provides a historical background to the discoveries on which our current understanding of the process is based. The 'edifice of photosynthesis research' owes great debts to pioneers in the 17th, 18th and early 19th centuries, highlighted in this chapter. **Chapter 2** focuses on the nuts and bolts of the photosynthetic apparatus emphasizing the structures and the chemical components; thus, what makes photosynthesis *tick* is answered here. **Chapter 3** is devoted to the light-dependent reactions, the heart of the process of converting solar energy into biological energy. It is here that reader will find an in-depth discussion of the so-called Z-scheme of photosynthesis. **Chapter 4** completes the process of photosynthesis, i.e., the use of NADPH and ATP, the two major products of the light-dependent reactions, in producing carbohydrates by C3 (plants like rice) and C4 (plants like maize) carbon reduction pathways. The regulation needed for photosynthesis to perform optimally under different environments is addressed in **Chapter 5**, where we provide a concise picture of the regulation mechanisms that plants have developed and adapted to survive and excel under various conditions. These include the so-called "*state transitions*", where pigments move from one photosystem to another to balance light absorption for optimum overall photosynthesis, as well as "Non-photochemical Quenching (NPQ) of the excited state of chlorophyll *a*", one of the photoprotective mechanisms by which plants, algae, and cyanobacteria protect themselves in excess light. In **Chapter 6**, we discuss the impact of photosynthesis on the global environment and **Chapter 7** deals with anoxygenic photosynthesis by photosynthetic bacteria where water is not oxidized to oxygen, but instead other compounds such as H_2S are used as the primary electron source for these single photosystem organisms. **Chapter 8** deals with the fascinating story about the

evolution of photosynthesis. **Chapter 9** ends the book featuring excitement around research in artificial photosynthesis. Finally, we remind the readers that we must move forward on all fronts to solve global challenges, using the knowledge of photosynthesis. We must not be afraid to make mistakes. As Jules Verne (in *A Journey to the Center of the Earth*) said, "*Science, my lad, is made up of mistakes, but they are mistakes which it is useful to make, because they lead little by little to the truth*". Let there be light and let there be hope. We hope that the readers will enjoy and learn from our book and work to improve our World.

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