# Preface

This book, *The Structural Basis of Biological Energy Generation*, provides a detailed overview of the structural foundation for bioenergetics in bacteria, algae and plants from the molecular to the organism level. The authors of the chapters review our current understanding of how organisms channel energy gradients into generating the living world. Thus the book illustrates the mechanisms employed in these organisms to efficiently capture light energy, transport electrons and protons, and fix carbon.

In addition to chlorophyll-based photoconverters, a fundamentally different type of photoconverters, rhodopsins, convert light energy into a trans-membrane proton gradient using conformational changes of the carotenoid retinal. The molecular mechanisms that underlie the light conversion by rhodopsins is the topic of Chap. 1. The capture and utilization of light is the energetic basis of all organisms that inhabit ecosystems on the surface of Earth. A careful description of the molecular mechanisms that facilitate light harvesting is provided in chapters reviewing light-harvesting complexes of heterokont algae (Chap. 2), peridinin-chlorophyll proteins (Chap. 3), phycobilisomes (Chap. 4), and chlorosomes (Chap. 5). Current models for the biogenesis of chlorosomes and phycobilisomes are also reviewed in detail in Chaps. 4 and 5. An in-depth analysis of how light penetrates the complex organ for light capture by plants is provided in Chap. 19. The influence of morphological and environmental factors on photosynthesis in lichens is discussed in Chap. 20.

Several chapters provide molecular insights into electron and proton transport within protein complexes. Chapter 6 explores structure-function relationships of ATPases found in different groups of organisms. Coupling electron transfer to proton-translocation is the topic of a chapter on Cytochrome $b_6f$ and $bc$ complexes (Chap. 8). Electron transport to oxygen in quinone oxidases (Chap. 9) and cytochrome oxidases (Chap. 10) are explored using structural and computational approaches. Methionine sulfoxide reductase recovers proteins damaged by electron transport to oxygen (Chap. 11). In addition to their destructive action in mitochondria, reactive oxygen species are also an important signaling molecule in mitochondria (Chap. 24).

Biological systems employ compartmentalization to efficiently execute cellular functions. Protein complexes can provide sophisticated compartments for light-harvesting (Chaps. 4 and 5), carbon fixation (Chap. 7), and coordinated proton and electron transport (Chap. 12). In addition, membrane systems also compartmentalize the respiratory (Chaps. 15 and 21) and photosynthetic (Chap. 16) energy generation machinery. Structural and physiological insights into energy generation of bacteria and algae are provided in chapters with a focus on heliobacteria (Chap. 13), cyanobacteria (Chap. 14), mycobacteria (Chap. 15) and green algae (Chap. 17).

The ability to convert inorganic carbon into organic molecules is the defining characteristic of autotrophic organisms. Carboxysomes are complex protein assemblies with the function to locally increase the amount of inorganic carbon. The molecular structure of carboxysomes is reviewed in Chap. 7, and insights obtained from imaging carboxysomes in cyanobacteria are provided in Chap. 14. The mode of concentrating inorganic carbon is also the focus of a chapter on diatoms (Chap. 18). In addition, the potential utilization of fixed carbon for the production of biofuels and carotenoids in different green algae is reviewed in Chap. 17.

Mitochondria and chloroplasts are the result of endosymbiotic events. Therefore many functional elements can only be understood in an evolutionary context. This is especially true for the machinery employed in the biogenesis of chloroplasts (Chap. 23) and mitochondria (Chap. 24). Physiological and structural characteristics of the red algal chloroplast (Chap. 16), mitochondrion (Chap. 21) and the mitochondrion-derived hydrogenosome (Chap. 22) exemplify the transformation of bacteria into organelles specialized for light energy conversion and energy generation in the presence or absence of oxygen.

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**Martin F. Hohmann-Marriott**
Department of Biotechnology,
Norwegian University of Science
and Technology, NTNU,
N-7491 Trondheim, Norway
martin.hohmann-marriott@ntnu.no

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