Together with the previous volume in this series (Volume 15: Respiration in Archaea and Bacteria: Diversity in Electron Transport Carriers; see my book review in Photosynth Res (2005) 83:363–364), the current volume completes a comprehensive and very enlightening coverage of the wonderful diversity of respiratory systems and their components. Whereas the last volume was organized around the redox enzymes that comprise these systems, the current volume is more concerned with their organization and physiological roles in archaea and bacteria. The previous volume was very timely due to the recent advances in the structural biology of the electron transport systems. Similarly, the current volume is particularly well timed because of the wealth of genomic information now available for so many of the organisms of interest. Davide Zannoni deserves much credit for his choice of authors and guidance to maintain not only a uniformly high quality of chapters, but also in making sure that the chapters are accessible to a wide audience. Each of the chapters in this book, as in the last volume, present a nice overview with enough, but not too much detail, to educate the reader. References are ample and make it easy to follow-up on any of the topics.

The book is organized in 13 chapters according to the respiratory systems of different organisms or groups of organisms. The first chapter is written by Günter Schäfer on the oxygenic respiratory chains in Archaea, which is an area in which he is a major contributor. This chapter describes the unique respiratory complexes and auxiliary cofactors that are found in this group of organisms. The next chapter, by Nobohito Sone, Cecilia Hagerhäll and Junshi Sakamoto, discusses the aerobic respiratory systems of Gram-positive organisms. This includes the thermophilic and alkaliophilic bacilli and the high G+C organisms such as Corynebacterium glutamicum. Without an outer membrane, the Gram-positive organisms have evolved various mechanisms to use cytochrome c as an electron carrier but without allowing this small protein to diffuse out of the cell. In some cases, the cytochrome c is tethered to the membrane by either a transmembrane helix or by a covalently attached lipid. In other instances there are additional domains containing c-type heme, which are appended on the framework of either the bc1 complex or the terminal oxidase. There is a separate chapter by Jonathan D. Myers and David J. Kelly discussing the respiratory systems of the gastro-intestinal pathogens, Helicobacter and Campylobacter. These are microaerophilic bacteria that can also use alternate electron acceptors such as fumarate, nitrate and nitrite. Helicobacter strains are unusual insofar as they have only one terminal oxidase (of the cbb3-type), whereas Campylobacter has both a cbb3-type and a bd-type of oxidase. Understanding the physiology of these organisms is important to determine how they have become specialized to colonize the stomach and intestinal lining.

The acetic acid bacteria, described by Kazunobu Matsushita, Hirohide Toyama and Osao Adachi, are obligate aerobes. These organisms have evolved to rapidly oxidize alcohols and sugars using enzymes located in the periplasm and not, as is more common, in the cytoplasm. The enzymes involved in these...
dehydrogenase reactions are complexes containing quinoproteins, flavoproteins and cytochrome c. It is speculated that a primary role of these respiratory systems is to rapidly accumulate the oxidized products of these reactions in the media for the purpose of reducing the growth of competing bacteria, which generally have difficulty in utilizing these compounds as energy or carbon sources. The acetic acid bacteria also have an as-yet uncharacterized CN-resistant bypass oxidase, which allows the cells to maintain high rates of the oxidation reactions, but without energy conservation. The oxidation of substrates outside the cell as a source of electrons is also a major feature of *Thiobacillus ferrooxidans*, an aerobic chemolithotroph, and *Wolinella succinogenes*, a sulfur-respiring anaerobe. The bioenergetics of *Thiobacillus ferrooxidans* is described in the chapter by W. John Ingledew, and there is a chapter on sulfur respiration by Oliver Klimmek, Wiebke Dietrich, Felician Dancea, Yi-Jan Lin, Stefania Pfeiffer, Frank Lühr, Heinz Rüterjans, Roland Gross, Jörg Simon and Achim Kröger. Each are excellent summaries of what is known about the respiration and energy conservation systems of these bacteria.

Two interesting chapters cover, respectively, the bioenergetics of organisms that use the energy derived from aerobic respiration to fix nitrogen to form ammonia, and the bioenergetics of organisms that derive the energy needed for growth by oxidizing ammonia under aerobic conditions. The chapter on the interplay between respiration and aerobic nitrogen fixation, in organisms such as *Bradyrhizobium japonicum*, is written by Robert J. Maier. The chapter on the oxidation of ammonia by *Nitrosomonas europaea* has been contributed by Alan B. Hooper, David Arciero, David Bergmann and Michael P. Hendrich.

Another fascinating group of organisms is the methanotrophs, which are Gram-negative bacteria that use methane or methanol as the sole source of both carbon and energy. This topic is covered by Alan A. DiSpirito, Ryan C. Kunz, Don-Won Choi and James A. Zahn. Methane is oxidized to CO$_2$ and the electrons are used by the aerobic respiratory chain. The key enzymes of interest in these organisms are the methane monooxygenases. Since this chapter was written, the X-ray structure of the particulate (membrane-bound) enzyme was reported (Lieberman and Rosenzweig (2005) Nature 434:177–182), but this chapter is mostly concerned with the interplay of the various enzymes needed for the overall pathways used by the organisms.

Stuart J. Ferguson and David J. Richardson do an admirable job reviewing the enzymes and bioenergetics of nitrate, nitrite, nitric oxide and nitrous oxide respiration. There has been a considerable impact in this area from structural biology of these components as well as sophisticated spectroscopy, and these are well described. Of interest also is the phylogenetic relationship between the NO reductases and the aerobic oxidases.

The topic of hydrogen respiration is reviewed by Paulette M. Vignais, John C. Willison and Annette Colbeau. The diversity of hydrogenases and their different roles in respiration is complex but nicely clarified by this chapter. H$_2$ can be oxidized to provide electrons or, protons can be electron acceptors and be reduced to form H$_2$. Electron transfer either to or from H$_2$/H$^+$ is an important component of anaerobic respiration by both bacteria and archaea and these reactions are coupled to form a proton motive force.

The final two chapters in the book discuss organisms in which photosynthetic electron transport coexists with respiratory systems. Georg Schmetterer and Dietmar Pils discuss cyanobacterial respiration and André Vermeglio, Roberto Borghese and Davide Zannoni cover facultative photosynthetic bacteria (e.g., *Rhodobacter capsulatus*). These chapters introduce the reader to systems where there is spatial segregation of components between the cytoplasmic membrane and intracytoplasmic membranes (or thylakoids in the case of the cyanobacteria). The interactions of the respiratory and photosynthetic systems are complex and far from understood. Some components are shared, and others are not. Much effort has gone into studying the regulatory systems, which control the amount of each of these systems that is present under particular growth conditions.

For further information on both volumes 15 and 16 on ‘Respiration in Archaea and Bacteria’, see the announcement, by Govindjee, of their release by Springer (Photosynth Res (2005) 81:201–204).

No single book can cover all topics related to this area. It would have been nice to have a chapter on *Geobacter* and other bacteria that can reduce solid iron oxide and have novel components located on the cell exterior to facilitate this form of respiration. A chapter on the respiratory components and bioenergetics of methanogens would also have fit nicely in this book. Nevertheless, there is plenty here to make this book a good investment.

The material in this book provides a bridge between the biophysics and biochemistry of the individual enzyme components and the complex physiology of the organisms in which these components function. Having all this material in one place is valuable to those of us doing research in the area, but also provides to anyone