Preface

This volume is a compilation of articles that present the recent data and the novel outlooks at the diverse areas of the methylotrophy field, encompassing the fundamentals of this research field, such as updates on the biochemistry, physiology and systematics of methylotrophs, as well as the newly emerging areas, such as laboratory evolution of methylotrophs, enumeration of methylotrophs in novel environments such as clouds, and experimenting with synthetic methylotrophs and methylotroph communities. In general, methylotrophy is a rather small field within the broader field of microbiology. While over one hundred years of age, the field has been experiencing a remarkable rejuvenation, partly fuelled by the omics capabilities, but also defined by the bold new questions that the established as well as the newly emerging methylotrophysts want to approach. The young and upcoming methylotrophy researchers were especially welcomed to contribute to the volume. Focused articles featuring results from specific research areas/teams have also been encouraged.

In Chapter 1, Semrau and DiSpirito provide a review of the current knowledge on the aerobic methanotrophy and describe the potential of these organisms for environmental, industrial and medical applications. In Chapter 2, Knief provides an extensive overview of methane-producing and methane-consuming microbes from diverse environmental niches, along with a comprehensive update on the classification of microorganisms involved in the global methane cycle. In Chapter 3, Smith and Wrighton provide a metagenomic insight into methanotrophy, through the analysis of the currently available sequence datasets, originating from a variety of environments. In Chapter 4, Khmelenina and colleagues present recent insights from comparative analyses of properties of some key enzymes in methylotrophy, and discuss the recent adjustments to understanding of key metabolic pathways in aerobic methanotrophy. In Chapter 5, Skovran and colleagues elaborate on the newly emerged role of lanthanides in methylotrophy. They present data on the complex regulatory networks involved in balancing the roles of alternative methanol dehydrogenases, and they review the potential of lanthanide enzymes for biotechnological applications. In Chapter 6, Czarnecki and Bartosik provide detailed overview of methylotrophy in species of the genus *Paracoccus*, revealing great variability of C1 metabolism in these species and discussing potential evolutionary mechanisms for such metabolic flexibility. In Chapter 7, Mausz and Chen summarize the latest developments in analytical methods for quantifying methylated amines in marine waters and sediments, and they discuss the metabolic pathways leading to the formation and the degradation of methylated amines, with a special focus on the novel biochemistry and structural biology of the enzymes for these transformations. In Chapter 8, Bringel and colleagues present the state of the art of the knowledge on microbial degradation of chloromethane, an important atmospheric pollutant, uncovering the many unknowns that still exist in both understanding the pathways for chloromethane degradation and the microorganisms/communities contributing to the global chloromethane cycle. In Chapter 9, Schäfer and Eyice provide an update on the diversity of microorganisms involved in the production and the degradation of methanethiol, an important methylated intermediate in the global sulfur cycle. In Chapter 10, Yu and colleagues present the recent data that support the communal function

in aerobic methane oxidation, including insights from manipulation of synthetic methanotrophic communities. They further elaborate on the role of lanthanide-dependent alcohol dehydrogenases in methylotrophy, and on the multiple factors that regulate these enzymes. In Chapter 11, Yurimoto and Sakai describe the physiology of methylotrophic yeasts that proliferate and survive on plant leaves, feeding on the excreted methanol. They focus on the specific adaptations for the life in the phyllosphere, which include the specific mechanisms for sensing methanol. In Chapter 12, Puri introduces an emerging subfield of methylotrophy, dealing with the potentially methylotroph-specific specialized (secondary) metabolites. The author examines the predicted biosynthetic potential of several methylotrophs, and reviews some of the specialized metabolites that have been recently characterized from these organisms. In Chapter 13, Zheng and colleagues review the recent progress towards engineering a model methylotroph, *Methylobacterium extorquens*, towards industrial production of several platform chemicals from methanol, as well as the recent progress in engineering synthetic methylotrophs based on the established industrial strains of bacteria and yeasts. In Chapter 14, Claassens and colleagues discuss the use of a step-wise, modular engineering approach for synthetic implementation of pathways for assimilation of carbon from methanol and formate, this approach providing opportunities for identification and resolution of metabolic barriers hampering pathway performance, these being essential for rewiring microbial metabolism towards the desired growth phenotypes and sustainable bioproduction. Finally, in Chapter 15, Marx describes his personal account of the development of *Methylobacterium* as a model system for experimental evolution, designed to study questions at the intersection of metabolism and evolution, a 15-year long journey. As such, the volume covers a remarkable diversity of the topics relevant to methylotrophy, and thus well represents the current state of the field. It should be useful for a wide audience, both researchers familiar with the concepts and the details of methylotrophy metabolism, and the newcomers to the field. I want to thank all the authors for their contributions. I thoroughly enjoyed reading each chapter, and I hope the future reader finds the volume as enjoyable as informative.