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Polar microbiology is a fast-growing field that can tell us much about the fundamentals of life on earth and the microbial contributions and consequences to such important global environmental issues as warming earth, ozone depletion, and elemental cycling. Polar microbiology has also recently received considerable attention because polar microbial communities are considered important analogues for astrobiology investigations looking for life on other very cold solar system bodies.

Over the last 20 to 30 years, microbiologists have had increasing access to the previously difficult to reach polar regions, which has resulted in tremendous progress in understanding the microbial ecology of these regions. This research has opened a door to a greater understanding of the physiology of the hardy microbial inhabitants of these extremely cold environments. During the International Polar Year of 2008, many international microbial investigations focusing on Arctic and Antarctic regions were conducted. They often lasted for a 3- to 4-year period. This book is a celebration of research undertaken in this exciting field of microbiology during the International Polar Year and over the 10 to 20 years that preceded it.

This is the ideal time to summarize the research carried out over the last decade that has increased our knowledge of the microbiology of the Arctic and Antarctic regions in our world. Much of the research initiated during the International Polar Year has been completed and the data compiled and analyzed. Now is the time to reflect on the major findings and conclusions that can be drawn from the International Polar Year’s activities. This book was inspired in part by the presentations at the 2008 International Polar and Alpine Microbiology Conference in Banff, Canada, where many of the contributors to Polar Microbiology first discussed the project.

Polar Microbiology has been created as a book that addresses polar microbiology in a general fashion and is designed to inform a broad audience of microbiologists on the microbial ecology and physiology of this fascinating world.
of ice and snow. *Polar Microbiology* is targeted toward a general microbiology audience rather than to just the polar microbiology community because it is our hope that this book will become a useful reference and general polar microbiology textbook for scientists and students in all areas of biology and geomicrobiology.

To this end, we asked the authors to first give a general overview of their particular area of polar expertise, outlining the major advances and general themes and principles of the subject. The authors were also asked to include the most relevant highlights of recent findings and to provide future questions that should be explored in their field. They were encouraged to compare the Arctic and Antarctic environments wherever appropriate and to comment on the effects of climate change on these fragile ecosystems. The High Arctic in particular is experiencing the greatest increases in temperatures on the planet, with subsequent detrimental effects, including habitat destruction (Vincent et al., 2009).

The world’s leading scientists in Arctic and Antarctic microbiology have written *Polar Microbiology*. The book is organized into four major thematic sections. In Part I, “Microbial Diversity of Polar Environments,” we start with a survey of what is currently known (surprisingly, quite a bit!) and what is not known (paradoxically, still quite a bit!) about the microbial inhabitants of polar environments. Here, the diversity of the four major microbial groups—bacteria, archaea, viruses, and eukaryotes—found in polar environments is presented separately in four chapters.

Part II addresses the adaptations and physiology of cold-adapted microorganisms. General aspects of the theme are discussed in Chapter 5, while exciting new discoveries revealed by genomic, proteomic, and metagenomic analyses are described in Chapters 6 and 7. This section concludes with a chapter on how this information is being used to increasingly develop and utilize cold-adapted microorganisms for biotechnological applications.

In Part III, “Ecology and Biogeochemical Cycling of Polar Microbiology Communities,” the significant ecological role and the importance of polar microbial communities in biogeochemical cycling is addressed through specific contributions focused on the major polar environments. These include (i) polar terrestrial systems, especially permafrost; (ii) polar marine systems; and (iii) cryosphere environments, including glaciers, ice shelves, and sea ice ecosystems.

Part IV of the book presents the challenges microorganisms face living in polar and subpolar environments and explores the low-temperature limits of microbial life. Growth, metabolism, and activity are addressed in Chapter 12. How climate change and ozone depletion are affecting polar communities is outlined in Chapter 13. Chapter 14 discusses how polar microbiology has become increasingly important to astrobiology and the search for microbial life on other worlds. Indeed, the primary targets for astrobiology investigations of other solar system bodies are Mars, in the short term, as well as Europa and Enceladus, in the mid- to longer term. Extremely cold temperatures characterize these targets, and as such, the best terrestrial analogues may be Earth’s polar regions.
We envision *Polar Microbiology* as a summation for a general audience of the major aspects of our current knowledge of the amazing diversity, ecology, adaptations, and utility of microorganisms living and thriving in the coldest regions of our planet. We hope that you, the reader, both enjoy it and find it to be a useful resource. We offer our sincere thanks to the amazing authors who spent considerable time and effort preparing and revising their contributions to this endeavor; we are truly grateful for their insights expressed in such a readable way.

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