# Preface

We, as scientists, find ourselves in an era of retooling both the technology and the concepts of biology on account of access to global information on an unprecedented scale, through whole genome analysis and community sequencing. This revolution has affected the field of extremophiles, perhaps to a greater extent than most areas of microbiology, due to the challenges posed by carrying out many routine investigations at high temperature. As a result, the database-induced change in *modus operandi* has pushed back the frontiers of discovery on thermophiles rapidly over the last decade. We, the editors, felt that this book would be a timely contribution to sum up some of the most exciting areas of growth in the field. We have focused on thermophiles, those bacteria and archaea adapted primarily to heat, although many thermophilic species also withstand high osmolarity, high hydrostatic pressure, low or high pH, toxic metals, or organic solvents.

Many of the species in common use in this field were isolated and characterized by the pioneers of the field, including Karl-Otto Stetter, Carl Woese and the late Wolfram Zillig. Many of the extraordinary microbial species "in captivity" as a result of their efforts represent a very important window into the microbiology of marine hydrothermal vents and geothermal systems. Hydrothermal vent circulation is becoming more relevant as awareness of global climate change increases. Current estimates suggest that the circulation of seawater through the oceanic crust accounts for 34% of the heat input into the global oceans, about 25% of the globe's total heat input. Hydrothermal vents may regulate the chemistry of the global oceans and could be responsible for the elemental composition of seawater, and we are aware from pioneering studies that autotrophic thermophiles are abundant and active in volcanic outflows. Much work remains to be done on the microbiology of hydrothermal systems in general and although this book is not focused on environmental microbiology, our knowledge of molecular insights into thermophilic lifestyles, and the development of new genetic tools are critical to the design of future field studies of thermophiles.

Our main goal was to capture the excitement that currently prevails in the field of thermophile molecular biology. Examples of some of the topics include the description key adaptive mechanisms of hyperthermophiles and acidophiles, and the genetic methods that will be in the toolkit of all thermophile laboratories in future. Many practical applications of thermophiles and their enzymes have also recently matured and there has been a true "coming of age" of technology derived from thermophiles and other "extremophiles." Our purpose was to capture some of the most exciting and innovative advances in the area of applications.

We also sought to highlight areas where thermophiles provide model systems for complex cellular functions. These include DNA replication and repair, protein phosphorylation, osmoregulation and the enhancement of thermal stability by unusual compatible solutes, and protein folding systems. In many cases, thermophiles have provided critically important advantages to study complex multicomponent systems due to their inherent stability at high temperatures, leading to extreme durability and minimal thermal transitions at "normal" temperatures. An excellent example of the "thermophile advantage" is the resolution of the structure of the first 70S ribosome structure using *Thermus thermophilus*, a hot spring bacterium, as the source organism (see Chapter 18). In addition, the extremely thermophilic Archaea are "miniature" Eukarya in the sense that the foundational mechanisms of many complex functions such as DNA replication and transcription are identical, accomplished however with far fewer components in the Archaea. This leads to profound advantages in assigning functions to each component.

We are greatly indebted to many people who saw the same vision and have provided essential help. The first to be thanked are without doubt the contributors who devoted valuable energy and time to their chapters. They are the authorities in the areas described above and without their unstinting help, the depth of review of our topics would have been much shallower. We are also most grateful for the patient and constructive help we received from Judith Spiegel and Amber Donley at Taylor & Francis, and the assistance of a number of reviewers in editing the initial drafts of the chapters.

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