Preface

Biological systems are regulated by the basic thermodynamic parameters of pressure and temperature. Life exists only within a closed range of pressure and temperature parameters: a pressure range from 0.1 to more than 1000 MPa, and a temperature range from –22 to more than 100°C, depending on the phase behavior of liquid water as the pressure and temperature change. Pressure has an effect on the environment of biological systems in a continuous, controlled way by changing only intermolecular distances. Temperature produces simultaneous changes in both volume and thermal energy.

In recent years, there has been increasing interest in exploiting the effects of pressure itself and pressure combined with temperature on biological systems. One of the reasons is the possibility of applying pressure in food processing. Also, pressure can be used to provide more detailed and unique information on biological systems. Modern technical progress with various kinds of spectroscopes, FTIR, NMR, solution X-ray analysis, molecular dynamics simulation, flash photolysis, and stopped-flow methods, has made it possible to study the structure and function of biological systems under extreme conditions of pressure and temperature.

The deep sea was perceived as a cold (around 0°C), dark, and high-pressure (around 100 MPa) environment inhabited by barophilic microbial communities. In contrast, deep-sea hydrothermal vent areas are warm to hot reaching around 350°C at a depth of 2000 m (20 MPa), and are inhabited by thermophilic communities. The survival and adaptive mechanisms of microorganisms at extreme conditions are important in the understanding of the function of deep-sea microorganisms. The explanations of these functions are anticipated to explicate the origins and evolution of life.

There has been a long history of heating and freezing in food processing. During the past several years, pressure and temperature effects on biological systems have been used in research into high-pressure processing in the food industries, especially since the Japanese Research Association for High Pressure Technology in Food Industry was established in 1989.

In this book, we have collected together chapters covering in a wide range of subjects from the basics to applications of the structure and function of biological systems under extreme pressure and temperature conditions. This book is composed of four main research fields. The first field is on the basic theory of biological systems: water under extreme conditions. The second field is the recent advanced results and methods in the study of the structure and function of proteins with changes in pressure and temperature. The third field deals with the recent aspects of molecular biology in the deep sea and in deep-sea hydrothermal vents, and with the origins and evolution of life. The final field highlights one of the many trends in the use of pressure and/or temperature for microorganisms, a trend that appears to have many important future applications of the yeast *Saccharomyses cerevisiae*.

This book is intended to stimulate research in this field and to demonstrate the basics and applications of pressure and temperature effects. It is intended for students and researchers studying and exploring the new world of biological systems in extreme environments.

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