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Book review

Biological systems under extreme conditions: structure and function

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We have heard much about extremophiles – those branches of the microbial world that like to live in conditions that you and I would consider extreme. These environments include ones of high and low temperatures, high pressures and extremes of acid, alkalinity, high heavy metal concentrations and so on.

When I first saw this book it fired some enthusiasm in me because it seemed potentially to offer a review of the next logical step in enquiry – how do these organisms actually deal with these extremes? What is the physics behind being able to live in these environments?

However, the book is slightly disappointing as it almost exclusively focuses on high pressures and takes little time to examine other extreme physical and chemical environments despite its general title. A comparison to some other extremes would have made it a much more compelling contribution.

Nevertheless, the chapters are interesting. We start off with two chapters on water, the physics of water and why it is such an unusual substance. The material is not for the faint-hearted and is really aimed at the 'advanced student of water'. The next chapter, which looks at the physics and thermodynamics of proteins is followed by three chapters examining proteins under high pressures. The chapters look at ways in which we can study the properties of proteins under high pressure. For example, we are told about using Nuclear Magnetic Resonance (NMR) and X-ray crystallography in high pressure-tolerant vessels to study the ways in which protein structure changes in response to pressures. The field is advancing quite rapidly and I had no idea that high pressure NMR up to 900 MPa (about 10,000 atmospheres) has its own set of literature already.

The next two chapters focus on methods for studying the melting point temperatures of proteins and methods for studying enzyme kinetics under extreme temperatures and pressures which should be of interest to those who want to know about biochemical reactions in such conditions. All of these previous chapters are invaluable to the experimentalist trying to get an understanding of the laboratory practicalities of how to conduct microbiology and biochemistry under extreme conditions.

We then go back to pressure. A chapter on the effects of pressure on electron transfer is followed by four chapters that are much more general and cover the effects of pressure on microbial populations. Perhaps I am biased, being a microbiologist, but I found these chapters the best written in terms of their outreach to a general audience. The first one of these looks at microbes in the deep-sea and is followed by a discussion of the possible role of hydrothermal vents in the origin of life. The chapter following this discusses the effects of pressure on a range of microorganisms, providing an interesting comparison. The last chapter focuses specifically on yeast. Although these chapters veer back towards physiological responses they make a nice way to follow on from the more physical and methodological chapters described earlier. In these chapters we see the fruits of the research.

I would perhaps most recommend this book to microbiologists interested in the response of microbes to high pressures and the biochemical basis for this response. Nevertheless it may also be a very useful reference for anyone working on the biology of extreme environments who at some point might need to understand how high pressure affects organisms.

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