and his impressive appearance ("isn't he beautiful?" said a visiting lady biologist from Italy) there was a certain diffidence about him and a sensitivity which he kept well concealed from professional colleagues. It was the presence of Jean Medawar and the great understanding between them which provided the steel. Medawar could joke that it was the fortunate possession of an entirely happy marriage which gave him more time than certain of his colleagues to concentrate on work, but the joke was true.

It is hard — and disadvantageous with reviewers — to write a loving biography, particularly of a Nobel prizewinner who lends himself on so many counts to hero worship. But Lady Medawar succeeds brilliantly: she has written an unsentimental tribute to their relationship which is also genuinely revealing of the man — a man who thought that Wagner's plots were "all rot" but was transported by the music, an immensely significant footnote to his grasp of the imaginative as a source of insight, developed in his philosophical essays. Einstein played the violin, but I have the impression that, like a grounding in philosophy, this blakean receptiveness is in short supply among biologists.

There cannot be too many extant accounts of a relationship which was happy, passionate and intellectually reciprocal on quite this scale. Moreover, in view of Medawar's "very decided preference", his single-minded determination to press on regardless despite the torpedoes, and his complete lack of any expression of self-pity in the face of massive adversity, it is most fitting that we should have this account of his illness from the woman who shared it and supported him. There have been a few great scientific love stories — the Curies come to mind — but in chronicling this one, Lady Medawar adds to our knowledge of a great man and increases our admiration for a great lady. □

Alex Comfort is at the Windmill House, The Hill, Cranbrook, Kent TN17 3AH, UK.

Chaperones of the cell

R. John Ellis

Stress Proteins in Biology and Medicine. Edited by R. I. Morimoto, A. Tissières and C. Georgopoulos. *Cold Spring Harbor Laboratory Press: 1990. Pp.450. $97.*

ALL cells contain groups of highly conserved proteins that increase rapidly in concentration when the cells are exposed to environmental stresses, including those that cause human disease. The most studied stress is high temperature. There is much indirect evidence which suggests that stress proteins have a protective function, allowing cells both to recover from the inducing stress and to survive subsequent stronger stresses that would otherwise be lethal.

The study of stress (or heat-shock) responses at the molecular level has, until recently, concentrated on the mechanisms that cause these stress proteins to accumulate. A significant component of these mechanisms is the rapid increase in transcription of genes encoding stress proteins. Much detailed information is available about the regulatory DNA sequences and DNA-binding proteins involved, although the mechanism by which stresses are sensed to trigger transcriptional activation is not known. Even more unclear is the function of the diverse groups of stress proteins. The high degree of conservation of the amino-acid sequences among these groups in all organisms, together with the observation that many of the proteins are present when the organism is not subjected to stress, suggest that these proteins have functions essential to normal cellular operations but are required to a higher degree under stress conditions. In the past few years this area of stress-protein research has been stimulated by increasing evidence suggesting that many stress proteins function as molecular 'chaperones'.

Chaperones are a distinct family of proteins required in certain cellular processes such as protein synthesis and assembly, protein transport across membranes, and the functioning of oligomeric protein complexes such as those involved in DNA replication and the recycling of endocytotic vesicles. All these processes produce changes in the state of protein folding and/or oligomerization, and so all involve the transient exposure of interactive surfaces to the intracellular environment (interactive surfaces are any regions of intra- or intermolecular contact important in maintaining the functional structure). Such exposed surfaces run the risk that they may interact 'incorrectly' with one another to produce non-functional three-dimensional structures. The probability of incorrect interactions occurring is known to vary widely but to be increased at high protein concentrations and high temperatures.

Molecular chaperones function by recognizing and binding to such surfaces to form stable complexes in which incorrect interactions are inhibited. These complexes are then dissociated by other proteins, often using the energy of ATP hydrolysis, under circumstances where incorrect interactions are favoured. Chaperones convey no steric information for either protein folding or protein oligomerization, and neither bind to nor are components of the final functional structures — hence the term chaperone.

This concept can readily accommodate the functions of stress proteins if it is assumed that the primary effect of stress is to cause the appearance of interactive surfaces that are recognized by chaperones. For example, this model suggests that heat shock causes proteins to denature and form incorrect aggregates, whereas heat-shock proteins inhibit these processes by binding to the interactive surfaces produced by high temperature. Thus the stress response amplifies a pre-existing function which all cells require for their operation under non-stress conditions.

The recent evidence that supports this interpretation forms the more interesting part of this collection of 18 chapters covering many aspects of stress proteins in microbial and animal cells, including diseased human cells. As well as discussion of the molecular details of stress proteins, their genes and their mode of action as chaperones, there are chapters devoted to more organismal aspects such as the physiological adjustments to fluctuating thermal environments, the febrile response, immunological consequences of stress and the use of hyperthermia in cancer therapy. The quality of discussion and presentation is high, and each chapter is well-referenced — it would be hard to find a better introduction to the latest thinking in this field.

A final heretical thought — perhaps all stress proteins will turn out to be molecular chaperones (the converse is not true), in which case we should drop the terms 'stress' and 'heat shock', as these words refer to only one specialized aspect of the much broader, essential roles of these proteins. □

R. John Ellis is in the Department of Biological Sciences, University of Warwick, Coventry CV4 7AL, UK.

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■ Freeman has issued a second edition of *Electromagnetism: Principles and Applications* by Paul Lorrain and Dale Corson. The book is an abbreviated version of the more advanced *Electromagnetic Fields and Waves* by the same authors. Price is £24.95.

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■ *Chemical Bonding Theory* by Brian Webster introduces modern ideas about the chemical bond, with emphasis on molecular orbital theory. Publisher is Blackwell Scientific, price £14.95. (Also available in hardback at £29.50). □