advanced primates; other chapters, having a similar logic, concern changes in organization or in relative size of structures found throughout primates. Although some speculations on behavioural relevance are introduced, no convincing case is made for any of the proposed links of brain to behaviour.

The book as a whole falls uncomfortably between two stools: it provides very few new data for those familiar with the area, but does not form a comprehensive survey of major topics. Most of all, it lacks a detailed consideration of behavioural data. Primate brains are of interest primarily because we are primates, with remarkable intellectual capacities: in order to be sure that any of the brain features we examine are of general interest, we need to know that they are in fact related to intellectual activity, and that can be established only by considering behaviour alongside neurology. □

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Uncertainty principle of theology

John Habgood

Science and the Renewal of Belief.
By Russell Stannard.
SCM Press, 56–58 Bloomsbury Street, London: 1982. Pp.207 Pbk £2.95.

IN matters of religious belief it is not uncommon to find theologians in some ways more sceptical than scientists. No doubt the converse is also true. Those professionally engaged in a subject are likely to be more aware of its internal strains and inconsistencies, and the unanswered questions, than those who look at it as a whole from the vantage point of some other discipline.

Professor Stannard has a foot in both camps. A high-energy physicist, and one of the discoverers of charm in fundamental particles, he is also a Reader in the Church of England, who has found the developments in his own science a reinforcement to his faith. He uses his scientific knowledge effectively in tackling some of the major problems put to him by would-be believers, and for those who are stuck on such questions as evolution and the Bible, the reductionist view of human nature, miracles, or the alleged persecution of Galileo, his book has much to offer. I particularly like a discussion of the problem of evil, which draws on Dirac's concept of anti-matter to make the point that things have to be defined negatively as well as positively. His chatty style, frankness when he feels he has to offend some of the more simple Christian believers, and general no-nonsense approach to the subject, make this an attractive package which I am reluctant to criticize.

And yet. . . . In the end I am left with the impression that his would-be believers did not press him hard enough. It is too easy, for example, to claim that a serious experiment with prayer can answer the question of God's existence, in much the same way that a scientific experiment can verify the existence of charm. There is an analogy, certainly, but it sidesteps the major philosophical and theological problems in a way which should be impossible for somebody writing from within these disciplines. What seems to be lacking is the sense of mystery, and of theology's attempt to struggle with what is ultimately inexpressible.

There is a revealing passage right at the end of the book where Professor Stannard writes, "An advantage of being a scientist is that this inclination to sit on the fence is not one to which we are particularly prone. . . . Among the ranks of scientists are to be found atheists and Christians, but very few waverers in the middle". Precisely. Straightforward questions must have clear answers. The essence of science is so to arrange experience that clear answers can be given. But what if life as it is actually lived does not, and cannot, have the same kind of clarity? And what if God has to be found as much in the fog of uncertainty as in the light of faith? □

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Extra dimensions to globins

Warner E. Love

Haemoglobin & Myoglobin. Atlas of Molecular Structures in Biology, Volume 2.
By G. Fermi and M.F. Perutz.
Oxford University Press: 1982. Pp.104. £22.50, $49.50.

PROTEIN molecules are complex, intricately assembled three-dimensional objects. Different aspects of a particular molecule's structure will be of interest to different investigators, and in the end it may be that only three-dimensional models can suffice to fulfil particular needs. In the case of haemoglobin and myoglobin, structures have been determined at near-atomic resolution of molecules from different species, with different amino acid sequences and in different ligand states.

In this book G. Fermi and M.F. Perutz have brought together an enormous amount of data from widely scattered sources, spread over some 40 years of study, and have provided an excellent summary of our current knowledge of haemoglobin and myoglobin. The book is thus a good reference basis for further study of the literature, and should also be helpful to teachers faced with the problem of presenting an introduction to our understanding of how proteins work, i.e. how their structures subserve their physiological functions. In this regard, myoglobin and haemoglobin are good models; their structures are very well known and there is a large body of physiological and physical chemical data available for interpretation in terms of their structures.

In all cases thus far examined, those molecules that reversibly bind oxygen at an iron porphyrin binding-site incorporate that site into a polypeptide chain of approximately 17,000 MW, folded as is sperm whale myoglobin. Vertebrate haemoglobins are tetramers composed of two alpha and two beta myoglobin-folded chains. In the first part of the book, Fermi summarizes the relevant physiological phenomena, for example oxygen binding and cooperativity, and the influence of allosteric effectors such as CO_2, *p*H and organic phosphates. The amino acid sequences and intra-subunit hydrogen bonds of human and horse alpha and beta chains, and of sperm whale myoglobin, are given, the sequences are aligned and the helices designated. The contacts between subunits for human deoxy and horse met haemoglobins are illustrated in order to display the alterations in those contacts that occur upon the quarternary structure transition that accompanies ligand binding.

The descriptive material in Fermi's section sets the stage for 35 red–green stereodiagrams. These illustrate salient details of the three-dimensional structures, namely, skeleton diagrams of myoglobin and haemoglobin, their haem pockets, subunit interfaces and horse met haemoglobin helices.

In the second part of the book Perutz discusses fetal and adult mutant human haemoglobins from the point of view of how their deviations from the standard physiological behaviour of normal adult human haemoglobin can be rationalized in terms of the anomalies seen in their crystal structures. To date crystal structures of 20 different mutant haemoglobins have been determined, and the success with which their altered physiologies are explained in structural terms is one of the triumphs of modern X-ray crystallography.

I have already found this book useful, both in teaching and in my research. I have no doubt that others will find it equally valuable. □

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