effective intervention in the genome have been underestimated. Complications such as genetic control elements that act over a long distance, and overlapping gene domains, make clean genomic intervention difficult. The use of model systems and molecular analysis of human disease is giving us insight into the complexities of gene regulatory mechanisms, and it seems premature to tinker with many of these delicate systems. The amazing thing about mammalian development is not that it sometimes goes wrong, but that it ever succeeds. ■

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Extremophiles in the raw

The Surprising Archaea: Discovering Another Domain of Life
by John L. Howland
Oxford University Press: 2000. 214 pp. £19.95, $29.95

P. G. Willmer

Life just keeps on multiplying. When we were very young there were Animals and Plants, which Carolus Linnaeus happily confirmed for us, but which grew into three 'kingdoms' when we had to add on the unicellular things. At school we learned to recognize that unicells came in eukaryotic and prokaryotic versions, those respectively with or without their DNA packaged in a nucleus. A little later, and we had barely learned to love Lynn Margulis' definitive five kingdoms when the molecular lobby started to tell us that the two 'simplest' of these were each in themselves multiples of many kinds of unicellular life-forms. Now the evidence of molecular biologists is forcing us to recognize that not only can life be categorized into five, or even more, kingdoms, but also according to a parallel system of three 'domains' (Eukaryota, Bacteria and Archaea). John Howland's book takes us on a tour of the third domain, the Archaea. Prokaryotic, but not bacterial, they pursue their peculiar lifestyles in the more extreme environments of Earth, as they may have done for perhaps 3.5 billion years.

This biography of their discovery, and the gradual revelation of their unique biochemistry and adaptability, tells a fascinating story. The 'Surprising' of the title hardly does them justice; these creatures are genuinely amazing, and we all need to know more about them. This short book works as an introduction, but it could have been so much better if its target audience had been more carefully defined, without the jumps from chatty informality (reflected in sub-headings) to stilted academic prose. Some strange choices have been made about what needs careful explaining for the general reader and what is assumed knowledge, while biologists will find the background excessive and the repetition irritating. And instructions on how to obtain archaeal cultures are surely pointless for anyone.

Above all, the book badly needs improved illustration. The few figures are mainly of technical points; photographs don't appear until 80 pages in, and the quality is then so poor as to make them almost useless. The Archaea may not be very photogenic, but surely line drawings would give us a picture image to hang our thoughts around. Descriptions just won't do, unless they are brilliantly written; here, the narrations of the weird archaean cell structures, and their modes of division, are sometimes quite impossible to figure out.

The crucial question for me was how the Archaea differ from the other two domains. The key answer lies with molecular phylogeny; comparative ribosomal RNA analyses put them quite separate from Eubacteria — the other prokaryotes — and the eukaryotes (perhaps nearer the latter). But we are not told about the other key features of Archaea until the fourth chapter, and even then it is easy to get lost; I had to struggle to assemble my own list of what makes these organisms different. This wasn't helped by an unusually high error rate in text and captions; most are trivial and obvious, but when we are told that archaeal lipids contain "either" bonds instead of "ether" bonds, it only adds to the confusion. (And while we are quibbling, only genera and species should be italicized; here, the domains and sometimes the phyla get italics, perpetuating the muddle.)

The book comes into its own, though, in taking us through the breathtaking range of lifestyles and metabolisms of the Archaea. They are the real extremophiles — living in soda and salt lakes (where they pump chloride and nitrate out across their unique — sometimes purple — version of the cell membrane); in anoxic muds, animal guts and the rocky pillars of deep-sea vents (where they metabolize sulphides and release methane to compound greenhouse warming); and in hot springs in excess of 90 °C (where they manage to keep proteins and membranes functioning against all precedent). One species lives, bizarrely, only in the hot, deep wastes of coal mines, which can have only existed as a habitat for a few hundred years.

Later chapters give us real insight into the importance of the Archaea, and what they may tell us about the Earth's original chimaeric, gene-exchanging life-forms, and possibly about potential life-forms deep within the apparently barren rocks of other extraterrestrial objects.

I had wanted to know more about the Archaea, and now do. And most biologists concerned with life's beginnings, the phylogeny of modern taxa and the adaptability of cellular machineries will appreciate this volume. The final chapter, on the future of the Archaea, should be compulsory reading, not just for those interested in genes, evolution and biodiversity, but also for fuel scientists, chemical engineers and pharmacologists, who may well find that the Archaea have already solved some of their problems for them. But we might have learned more, and more easily, if its text had been shortened to reduce repetition, and the space devoted to tabulations, flow diagrams and drawings. Let's hope that some publisher hears this plea to multiply the media, as well as the taxa. ■

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