The Periodic Table and the meaning of life

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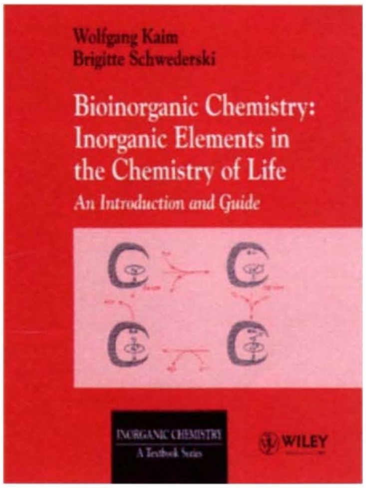
Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life.
By Wolfgang Kaim and Brigitte Schwederski: John Wiley & Sons, Ltd, Baffins Lane, Chichester, West Sussex PO19 1UD, England (Distributed in the US by Wiley & Sons, Inc. 605 Third Avenue, New York, NY 10158-0012, USA): 1994. 401 pages. £19.95, $31.95

It never rains, it pours: this is the third book of Bioinorganic Chemistry that has passed across my desk for review in the last year[1,2]. The good news is that this latest edition will appeal to many, although at a somewhat later stage in their education in chemistry since it is a relatively sophisticated text. As a consequence, the bad news (if, indeed, it is bad news) is that it cannot be used as early in a course as Lippard & Berg's book[2]. Nonetheless it is of equal value.

After a well-constructed introduction on general principles the book treats bioinorganic chemistry bit by bit or rather almost element by element. While such an approach allows the authors to concentrate on function and mechanism, it is hard to find a thread running though the chapters which would make the material cohere. I believe that first of all every biochemist and biologist should see that the Periodic Table is the basic starting place in the study of bioinorganic chemistry. It represents all that can be obtained by way of chemical diversity starting from elements. If this diversity was to be utilised easily within evolution an obvious way to proceed would have been to use the most available elements from each Group of the Table exploiting optimal functional value at low energy cost. After all, the eighteen Groups are different in that they are Groups of different chemical function. Since biological systems are chemical—and evolution selects for material advantage—it follows that all extant biological systems should use elements from 17 Groups



(where we ignore the eighteenth Group, the noble (inert) gases).

How does this expectation stand up to experimental analysis? The answer is very well indeed. The elements used by biological systems are H, Na(K), Mg(Ca), B, V, Mo(W), Mn, Fe, Co, Ni, Cu, Zn, C(Si), N(P), O(S), Cl (other halogens) where underlined elements are only essential for some living organisms. The missing groups are 3, 4, 5 and 13, that is those with high valent cations. The suggestion is that such cations, for example Al^{3+}, bind so strongly to groups such as phosphates that they block essential reactions and compete with valuable binding of more lowly charged cations such as Mg^{2+} and Ca^{2+}. The common use of at least 13 of the 17 groups leads me to suggest that bioinorganic chemistry, and indeed all biological chemistry, should be organised around the Periodic Table as in chemistry. Now while the book under review has ten chapters which deal with element function by Group the order is seemingly arbitrary: Co, Mn(Mg), Fe, Ni, Cu, Mo(W,V,Cr), Zn, Na(K), Mg(Ca), non-metals. There does then appear to be good reason for a course organizer to re-arrange this order and to provide short connecting sections linking the changing chemistry to the biological value. All the individual chapters are well-presented as are added chapters on topics such as uptake, biominerals, toxicity and uses of radio-tracers so that the suggested rearrangment is, in fact, little work. Thus while I have no hesitation in recommending the book for a course for second or third year students, I do believe it incumbant on the teacher to impose the missing thread on the text. The book also demands some training in inorganic chemistry and a background course in bio-molecular structure is assumed.

With the new books on bioin-organic chemistry available it begins to be possible to put together a course for chemists and biochemists which is relevant to the future needs of our industrial society and which does not stress chemicals dissociated from life or life dissociated from the full impact of the chemistry it uses. It is not only time for the chemist to look hard at the subject matter he teaches but for the life science teacher to look carefully at the chemistry being taught.

1. Williams, R.J.P. *Nature struct. Biol* **1**,577–579 (1994).
2. Williams, R.J.P. *Nature struct. Biol.* **2**, 14–15 (1995).

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