can help bring about considerable improvements in the quality of life for their colleagues and themselves.

Our approach to unravelling some of these problems has been to introduce the use of computerised mathematical models based upon equilibrium calculations of these multiple-metal/multiple-ligand solutions. The model is, of course, an oversimplification but we must realise that a good simplification is a big advantage. Just as a map should not show all of the details of the terrain, our models aim to include only those biological and chemical features concerning low molecular weight complexes *in vivo*, the liberation of metal ions from metallo-proteins, the bioavailability and membrane permeability of metal ligand complexes, and strategies for encouraging metal ion complex excretion. The object is to imitate reality with such models and to make predictions based upon hypotheses. Scientific method demands that we use such an approach since the human mind cannot understand and remember the millions of biochemical facts at one and the same time.

Through defining objectives, setting up equilibrium models, and then designing experiments to try and answer the questions raised by such model computations, we have been able to tackle a large variety of problems. Details concerning the charges, stoichiometry, and some structural aspects of the low molecular weight complexes present in biofluids are thus obtainable permitting us to manipulate metal ions through a variety of *in vivo* reactions.

Upon the basis of these computerised analyses, we are able to construct correlations with known biological data (half lives, rates of excretion, response to medication, *etc.*). Examples of these features will be described in respect of adriamycin metal complexes *in vivo*, copper and rheumatoid arthritis, and chelating ligands designed to remove toxic metal ions.

References

1 A. M. Fiabane and D. R. Williams, 'The Principles of Bioinorganic Chemistry', The Chemical Society, London (1977).
2 P. M. May, P. W. Linder, G. Berthon and D. R. Williams, *J. Chem. Soc. Dalton*, 588 (1977); *idem*, 1433 (1978).
3 P. M. May, G. E. Jackson and D. R. Williams, *J. Inorg. Nucl. Chem.*, *40*, 1189 (1978).

On the Interpretation of Thermodynamic Quantities in Complexation Reactions

A. BRAIBANTI

Institute of Pharmaceutical Chemitry, University of Parma, Italy

Schwarzenbach presented a physico-chemical model of the complexation reaction, useful for the interpretation of entropy, ΔS° and enthalpy, ΔH° changes.

The main observations of Schwarzenbach concerning the thermodynamics of complexation between a ligand and a metal can be summarized as follows:

(*i*) complexes formed by metals with A-character show $T\Delta S^\circ \gg 0$ and $\Delta H^\circ \sim 0$ and complexes by metals with B-character show $T\Delta S^\circ \sim 0$ and $\Delta H^\circ \ll 0$;

(*ii*) the entropy term $\Delta S^\circ > 0$ is independent of A or B character and *it must be connected with the compensation of charges and be caused by structural changes occurring within the solvent*;

(*iii*) the enthalpy term ΔH° is not suited to measure bond energies, because *thermodynamic quantities are also influenced by the environment of the reacting species.*

The two classes of thermodynamic changes indicates in (*i*) can be found in the protonation of acids and bases, respectively. In every case the paramount importance of the processes at the solute–solvent interface is apparent.

The distinction between the internal processes (bond formation or bond cleavage) and the external ones (solute–solvent interactions) have been put by Hepler by stating that

$$\Delta S^\circ = \Delta S_{int} + \Delta S_{ext}$$

$$\Delta H^\circ = \Delta H_{int} + \Delta H_{ext}$$

In most cases in solution, $\Delta S_{int} \approx 0$ and $\Delta S^\circ \sim \Delta S_{ext}$. ΔS_{ext} can be therefore calorimetrically determined.

Other methods, *e.g.* relaxation experiments, can be used to enlight the properties of the solute–solvent zone and hopefully help to calculate ΔS_{ext} and ΔH_{ext}.

Computer-Assisted Methods for the Investigation of Solution Equilibria

PETER GANS

Department of Inorganic and Structural Chemistry, The University, Leeds LS2 9JT, U.K.

The computer is now widely used as an instrument for studying solution equilibria. The most complete description of a solution system consists of the values of the formation constants of all the species present, and the computer programs available for this calculation will be discussed and compared. However, a computer program that permits calculation of formation constants in complex systems must be supplied with the stoichiometries of all species believed to be