PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Introductory Remarks

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Introductory remarks

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I should like to begin with a word of apology. I know nothing whatever about biology – not even about the new biology, let alone about real biology. Indeed, I do not know if biologists still make this distinction, whether they still believe that there is a sharp discontinuity between non-living matter and living systems, whether they now think that there is a continuous transition between these extremes as the multiplicity of parts and the complexity of the organization involving them increase, or whether they have shelved this whole question as an arid semantic exercise. Anything that I may say about biology is therefore purely speculative; but perhaps I may be allowed to infer that something like continuous transition is at least allowed as a possibility since otherwise I do not see the point of this meeting.

'Biological recognition' I take to mean a specific reaction by a biological system, whatever that is, to a specific stimulus or specific situation. I suppose that this might occur at different levels of complexity and that these cover an enormous range; but whatever the level, the recognition process could, on the major premise already stated, have an ultimate physical and chemical basis. Presumably, what biologists are trying to do is to establish something like a hierarchy of sets of concepts and working hypotheses, each set suitable for explaining recognition at some particular level but itself explanable – more or less – in terms of the concepts used at a lower, i.e. simpler level. There may be an analogy with the use by chemists of the principles of quantum mechanics to explain the phenomena which they observe, so it is pertinent to recall how this has developed. We find a spectrum of applications. For simple molecules, e.g. diatomic ones, it is possible to use approximate methods to calculate numerical values for properties such as the energy of formation. By using more and more computer time it is possible to come closer and closer to the correct answer – and for energy, at least, there is a criterion for knowing that this is being approached. But there comes a time when the cost of further precision becomes too high to pay, and the calculation is then broken off. The answer is therefore imperfect, although experience shows that for such simple molecules a high degree of precision, sometimes better than that of experimental observation, is often reached by this time. For more complex molecules the process of calculation which is practicable is less rigorous, so methods with a more empirical basis or involving the introduction of empirical parameters are employed. For many purposes an even less rigorous, qualitative discussion is all that is practicable. Thus, although the concepts and ideas needed for discussion and explanation at these different evels could in principle be derived rigorously and quantatively, this is at present impracticable. At each level a degree of approximation, of empiricism, and of non-rigour enters. I am told that biology covers a much greater range of phenomena; so presumably many more levels of discussion are needed and, if the analogy holds good, at each one it is likely that approximation, empiricism, and non-rigour come in. The concepts at any one of these levels are not at present, and probably never will be, completely and rigorously derivable from those of the preceding level. What we can try to do is steadily to improve the rigour of these interrelations and where

necessary to eliminate concepts which prove on re-examination to be ill-founded – what I may call biomyths. Much has been done already; but the gap between the systems which can be treated rigorously and those which interest the biologist is still very great and one would like to reduce it perhaps, for example, by evolving some new intermediate levels of discussion. My guess is that the contribution of the 'new biology' has been to provide some such new levels.

The first task at this meeting is to present some of the major concepts and results which physics and chemistry can offer for use. Professor Buckingham will present those relating to intermolecular forces, both general and specific, and I hope that he will include some points of special interest to biologists, such as the forces between large molecules and the effect of a medium between them. Professor Symons will continue this theme, emphasizing the part which specific forces play in giving water and aqueous solutions a structure and showing some of the consequences.

Molecular shape is of profound importance in determining chemical behaviour. Even with general forces alone it can confer high degrees of specificity because it controls the number of close approaches between atoms and hence the strong attractions. If it is combined with specific forces between particular atoms or groups of atoms, there is an even greater degree of specificity. The molecule contains more units of information. From my own experience† I know that even for quite small molecules, containing up to ten atoms, we cannot begin to understand the intermolecular forces between them in a quantitative sense unless account is taken of shape and of possible specific forces. Professor Mary Truter will illustrate some aspects of this important theme by showing how complexing agents distinguish, or fail to distinguish, between different metal ions, and what some of the consequences are.

I ought to say that in this session there will be no general presentation of concepts of chemical reaction, such as activation processes and the free energy changes which occur in them, although ideally there should be because biologists are more concerned with chemical change than they are with static properties like chemical equilibria or aggregation. Biological reactions are often highly specific. This fact is commonly involved in 'recognition' and it should be explanable in terms of the free energy changes during reaction and, still more fundamentally, from the connection between these and molecular structure. Some papers in later sessions deal with applications of these ideas.

† L. E. Sutton 1974 *Archiv for Pharmaci og Chemi, Sci. Edn.* **2**, 105.

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