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Electron Transfer and Ligand Binding in Metallo Proteins

M. BRUNORI

Institute of Chemistry, Faculty of Medicine, I University of Rome and Department of Biochemistry, Faculty of Medicine, II University of Rome, Rome, Italy

The multiple biological roles of metalloproteins may be illustrated by those macromolecules which are involved in the transport of dioxygen and its utilization for energy production. Reversible binding is the basic feature of oxygen carriers, such as hemoglobins or hemocyanins, and the stability of the complex as well as the dynamics of ligand binding to the metal(s) is modulated by the interactions with the proteins. Likewise, electron transfer between metalloproteins and/or the final electron acceptor, dioxygen, involves metal ions (Fe or Cu in most cases), but the specificity and rates of the processes in question are under protein control.

The basic theme of this paper will be an illustration of the mechanisms of control exerted by the protein moiety on the intrinsic reactivity of the metal ions. It will be emphasized that the use of rapid reaction techniques is a very valuable approach to test the mechanism and to identify the intermediates involved in the control.

For the sake of clarity, the regulatory action of the protein may be dealt with at a different level. At the tertiary level, the immediate environment of the metal ion controls the intrinsic rates of either ligand binding and/or electron transfer, as illustrated by kinetic experiments on myoglobin and azurin (taken as prototypes). In multisubunit proteins, the quaternary state of the macromolecule is involved in the control of reactivity. The classical allosteric model has been widely used to describe cooperative effects in hemoglobin and hemocyanin; the general significance of the multiple quaternary state of a macromolecule will be illustrated by its applicability to cytochrome *c* oxidase, presenting a two-state kinetic model which accounts for some kinetic properties of this crucial enzyme.