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POISEUILLEAN LECTURE

BIORHEOLOGY, A FACTOR OF SCIENTIFIC PROGRESS

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The characterization of biorheology as an autonomous science with a precise place in the field of knowledge should not allow the biorheologists to forget the various aspects of the importance of this kind of research in the general scientific development; in addition to the study of its own domain, biorheology behaves as a stimulative agent for other chapters of science, from fundamental rheology up to biochemistry, biology and medical engineering.

It is well known that rheology of liquids has been initiated by the work of Poiseuille on the pulmonary microcirculation. The case of this medical man who changed into a physicist in order to elucidate a biological problem is typical of the part played in science by biorheology, not only as a tool of investigation, but also as an initiator or a catalyser of new researches. Many examples of this action of biorheology appear in various fields.

The complexity of the problems studied in biorheology comes up frequently against the deficiencies of fundamental rheology, and consequently biorheology ought to act as a stimulus for the improvement of the experimental methods of rheology and the extension of its phenomenological or theoretical analysis to more complicated cases. Thus the peculiarities of blood flow have led recently to establish very general relationships for the rheological behavior of concentrated suspensions with any structure depending on the stresses.

In other fields biorheological phenomena have been often at the origin of important theoretical and technical developments, or have served as models for the elaboration of new devices or products. Besides the knowledges on muscle biology, cellular biology or protoplasm structure, for instance, are greatly indebted to the study of rheological properties of these living systems for their present state of refinement, as shown in a few examples.

At a more modest level, problems of surface rheology of biological substances, such as lipids and proteins, have led to state precisely the notions of flow induced structure or phase changes, molecular deformability, and conformational stability of biopolymers. Rheo-optical studies (flow birefringence and rheoturbidity) of denatured protein suspensions have required the investigation of the flow induced aggregation processes, and the development of a general theory of the aggregation which has permitted recently to calculate the interaction energy between the blood red cells in the rouleaux from the data given by optical retrodiffusion measurements.

The main reason of this influence of biorheology on other chapters of knowledge is the fact that the complexity and often the apparent strangeness of the rheological behavior of some biological systems are so great that they enjoin the research of the hidden causes and parameters at more and more acute scale, frequently up to the molecular scale, which leads to a series of works in biology, biophysics and biochemistry.

In order to promote such an extension of biorheology it is necessary to study and describe as accurately as possible the rheological behavior of many biological systems, whatever its intricacy may be, and to search into the cause of every observed phenomenon. For that, the mechanical properties must be analyzed, step by step, from the macro- to the microrheological level. A tentative method of approach for the study of complicated systems is proposed on the basis of the introduction of the concepts of locally equivalent systems and simple tangential systems, and of apparent rheological coefficients, the exact significance of which is to be made clear by taking into account the interactions between the constitutive particles or molecules of these systems.