

MOLECULAR STEREO-ISOMERISM OF THE LIVING MATTER

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The first half of the 19th century was marked by a very important event: Louis Pasteur discovered the dissymmetric spatial configuration of the molecules in the living matter. The discovery gave rise to the theory of molecular dissymmetry, which helped explain the optical activity of substances as a function of asymmetry in the molecular structures (L. Pasteur, J. Van't Hoff, J.-A. Le Bel). It also marked the moment when studies of the functioning of the living nature at the molecular level were started, thus creating a new approach to the investigation into the origin of life.

Studies of the significance of asymmetry in the spatial configuration of monomers and biopolymers for the processes of life brought into existence two directions of research: the "stereo-physiological" and the "stereo-biochemical" one. They study the role of steric factors in the realization of the stereo-specific complementarity, which is a basic condition for the biochemical reactions, of which the physiological process actually consists.

Two questions had to be answered within the said research directions. The first is how, by what molecular-structural factors is the complementarity of the interaction of substances in biochemical reactions brought about. The second is what for is the asymmetry (chirality) of the fundamental building stones of the living matter needed; what is the biological essence of L-aminoacids in the proteins, of D-ribose in the DNA and of D-oxyribose in the RNA. These problems are being investigated into both experimentally and by way of mathematical modelling and computation.

The sources of an answer to the first question can be found in the works of E. Fischer who offered the concept of "key and

the lock" in 1894, which was based on the idea that "molecular geometry" plays a decisive role in the interaction of substances. Later on the problem of structural and physico-chemical mechanisms of complementarity was studied more in detail by P. Ritchie (1932), within the concept of the conformational intermolecular interaction by W. Astburie, L. Poling and R. Cori (1930ies), by the multipletic theory of catalysis of A.A. Balandin (1963), and also in the course of research of co-operative systems of the intra- and inter-molecular forces assisting in the discrimination and structural matching of chiralic and achiralic molecules and biopolymers (D. Rein, P. Schipper and S. Mason, 1960ies through 1980ies).

Along with the study of the structural causality of the stereo-specific complementarity, a lot of attention was paid to the deciphering of the physiological reason for the chirality of the biomolecules. The foundation for it was laid by L. Pasteur (1840ies through 1850ies). Two aspects of the problem became noticeable in the course of research. One pertains to the study of the origin of the biomolecular chirality per se, and the other - to the question why is the molecular foundation of life represented by the L-aminoacids and the D-sugars, and not by their antipodes. Initial research was done by W. Kuhn (1920ies) who discovered that rate and efficiency of biosynthetic processes goes down if the spatial configuration of the enzyme's molecule is distorted. At the same time it was discovered that enzyme remains inactive or racemates are being synthesized in a medium consisting of a mixture of D- and L-isomers. W. Astburie made an important conclusion based on these data: an identical spatial configuration of monomers is the necessary prerequisite for their polymerization.

Study of the role of the chiralic purity of the biomolecules in the polymerization and of the significance of chirality for the metabolic reactions became the essence of the stereophysiology and stereobiochemistry since the beginning of the 1970ies. As the result of this research it was found out that the enzyme-substrate complex functions cooperatively. This means that discrimination of chirality is effected by a complex influence of various forces including molecular conformational restructurings.

After L.Orgel put forward (1968) the idea that along with the genetic code living beings also bear the chiralic code, of which the purpose is to encode both the chirality of the monomers and the regularity of the biopolymeric structures built from them, an extensive modelling and a thorough experimental investigation into the functions of the chiralic code was started.

Beginning with mid-1970ies the problem came under the scrutiny of L.A.Morozov and of a number of Soviet researchers under the guidance by V.I.Goldansky. Composition of a monomeric medium (purely chiralic or racemic) was varied, and a polynucleotidic matrix was inserted into it. Then it was proven that matrix assemblage of the complementary chain is only possible on a chirally pure matrix and in presence of chiralic monomers.

The study of the significance of molecular-spatial factors for the activity of organisms yielded (in 1970-1980ies) some important data relevant for the theoretical and practical physiology, medicine and pharmacology. It turned out, for instance, that the absolute stereo-selection does not remain constant, if biologically active substances are introduced into the body. It was discovered that chiralic purity of

monomers is required in order to maintain the chiralic purity of the metabolism. Presently, the mechanism of ageing of living beings, of immune reactions, of various distortions in the metabolism and of the influence of pharmacological preparations on the organism are being studied within the framework of these ideas.

With the discovery of the molecular stereo-isomerism in the living matter a new dimension was introduced into the studies of the origin of life: attempts to understand the origin of an inherent property of the living matter which is the asymmetry of its molecular structures. The concept of L. Pasteur about the role of the "dissymmetrizing forces" was augmented by certain new ideas: the idea about the instability of the racemic equilibrium of stereo-isomers at the stage of the molecular-chemical evolution and the idea of spontaneous distortions of the mirror symmetry in the course of physico-chemical processes in the pre-biosphere. At present, the problem of the abiogenic origin of the molecular stereo-isomerism at the level of self-replicating molecular systems has become one of the issues of synergetics. Such is its contribution to the model of global evolutionism.