

ENZYME FUNCTIONING AND NONEQUILIBRIUM PHASE TRANSITIONS

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Nowadays, the mechanisms of regulation of enzyme activity attract growing attention. Even the cornerstone schemes and notions of enzymology, such as Michaelis-Menten's scheme or cooperativity, undergo permanent revisions. Theoretical interpretations of new data, however, remain within the standard chemical kinetics framework. Although this admits qualitative explanations of some regulation phenomena like performance of 'hysteretic' enzymes, many characteristic features of enzymatic reactions can hardly be accommodated. On the other hand, the inherent factors of enzyme functioning flux conditions, slow structural changeability, nonlinear feedback between fast reaction acts and slow conformational rearrangements provide a natural basis for self-organization phenomena. Thus, the enzyme functioning can serve as an example of self-organization on the lowest possible level, down to single molecules. We put forward this concept of dynamical molecular self-organization in early 90's and then developed its theoretical and experimental substantiations with the example of primary reactions of photosynthesis. Here, it is applied to Michaelis-Menten's scheme. Within this paradigm, the stable functional regimes of enzyme operation emerge and interchange/coexist due to analogues of nonequilibrium phase transitions determined by the strength of substrate-conformation interaction and controlled by substrate concentration. In particular, the phenomena like 'monomeric cooperativity' or self-inhibition naturally follow from even the simplest two-state model of an enzyme with an only binding site [1].

1. Christophorov L. N. AIP Advances, 2018, 8, 125326.