Chemistry's Kinetic Dimension and the Physical Basis for Life

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ABSTRACT It is becoming increasingly apparent that a generalized thermodynamic approach to chemical reactivity, in place since the pioneering contributions of Boltzmann and Gibbs a century ago, is unable to adequately explain, let alone predict, the entire space of chemical potentiality, and that more extensive exploration of the kinetic domain may be required. The relatively recent discovery of kinetically-governed processes, such as those observed in dissipative self-assembly, reveals the existence of a largely undiscovered kinetic domain for which we propose the general term *dynamic kinetic chemistry*. Our analysis suggests that all biological systems and associated sub-systems belong to this distinct kinetic domain, thereby enabling the placement of biological systems within a coherent physical/chemical framework. Such a classification appears to assist in bridging the problematic animate–inanimate conceptual gap as well as offering new insights into the origin of life (OOL) process. Additionally, the discovery of this kinetic domain has opened the door toward the preparation of active materials able to self-heal, adapt to environmental changes, and even communicate, mimicking what transpires routinely in the biological world.

Keywords: dynamic kinetic stability; origin of life; dissipative self-assembly; dynamic kinetic chemistry