Homochiral feedback: Asymmetric interaction between an achiral amino acid precursor and a chiral amino acid

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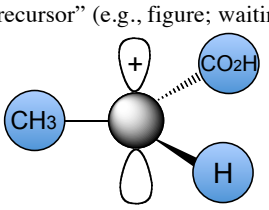
The one-handedness of amino acids and sugars is essential to the formation, structure, and function of biopolymers for the biosphere on Earth. Since the time of Pasteur, the development of specific chirality in terrestrial biomolecules has remained one of the most important issues with regard to astrochemistry, organic chemical evolution, and the early Earth chemistry. To date, number of hypotheses regarding the origins of homochirality have been presented from both aspects of biotic and abiotic processes (e.g., [1]).

D, L-alpha-alanine (C_3 carbon frame; potentially, including D, L-alpha-alanine precursors: [2]) is most abundant chiral amino acid in prebiotic chemistry, except of glycine (C_2). When we simply imagine a coin toss chemical reaction, prebiotic enantiomers are equally racemic outcomes as 50:50, likewise two sides of a coin. Among these racemic reactions (e.g., the typical nucleophilic substitution reaction inducing amino acid precursors), enantiomer-specific isotopic analysis (ESIA) showed infinitely homogeneous components for each enantiomer [3]. For further information of molecular-specific homochiral verification, here we developed an asymmetric feedback reaction with an "achiral amino acid precursor" (e.g., figure; waiting for amination) and "a chiral amino acid trigger", resulting in unique and large enantiomeric excesses as the continuous reaction products. Here, we discuss the reaction mechanism focusing on an amino acid precursor formula and a transition state inducing optically active amino acids.



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