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Importance of Sedimentation for Chiral Symmetry Breaking in Far from Equilibrium Peptide Systems

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Introduction: Chiral symmetry breaking in complex far from equilibrium chemical systems with large number of amino acids and large number of similar reactions was considered. It was shown that effective averaging over similar reaction channels results in very weak effective enantioselectivity of forward chemical reactions and that that averaging does not allow most of the known models to result in chiral symmetry breaking during formation of life on Earth. It was shown that such effective averaging does not apply to phase transition during sedimentation process due to high nonlinearity near solubility point.

Models with simple and catalytic synthesis of up to three amino acids, formation of peptides of up to length five, and irreversible sedimentation of insoluble pairs of substances were considered. It was shown that depending on the model and the values of the parameters, chiral symmetry breaking may occur in up to about 10% out of all possible unique insoluble pair combinations even in the absence of any catalytic synthesis. If weak enantioselective catalytic synthesis of amino acids is present, then the number of possible variants, in which chiral symmetry breaking may occur, increases substantially. It was shown that the most interesting catalysts and/or chiral resolving agents have zero or one amino acid of "incorrect" chirality.

An experiment of chiral symmetry breaking was proposed. The experiment consists of a three-step cycle: reversible catalytic synthesis of amino acids, reversible synthesis of peptides, and irreversible sedimentation of insoluble substances.