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The Role of Amines, Hydrogen Sulfide and Carbon Dioxide in the Formation of Prebiotic Macromolecules Surrounded by Membranes

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Amphiphilic compounds are known to self-assemble into membranous structures when exposed to alternate dry and wet conditions. This paper presents a model of how such structures could form near hydrothermal vents while containing macromolecules such as amino acids. The formation of amino acids near deep ocean hydrothermal vents as precursors for the origins of life is problematic as amino acids degrade from thermal energy. In the model proposed here, amino acids would degrade into amines (near hydrothermal vents). Amines have an affinity to interact with carbon dioxide (CO_2) and hydrogen sulfide (H2S), form weak heat-unstable salts, and then through exposure to thermal energy release the acid gases and regenerate back to amines. Amines carrying and releasing H2S and CO_2 would help other macromolecules form along with amino acids within protected cell-like structures; the cyclical release and recapture of acid gases would subsequently help the amino acids form bonds; further thermal action would degrade some of the amines into polymers that provide more strength and rigidity to the membrane walls; and also enable escaping gases to form tubes within the surrounding membranes for inlet and outlet of chemicals. Consider that liquids and gases are undergoing thermal convection inside a porous medium, and the convecting liquids contain some amines. Consider now that an amine weak salt carrying H2S and another carrying CO_2 is inside a vesicle that formed through self-assembly. As this vesicle moves around in the thermal convection cell it will come close to the heat source and release the H2S and CO_2 inside the vesicle. As the vesicle moves away from the heat source, the gases would be reabsorbed into the amines. This process would create stability and a repeating set of reactions, reactants, and products forming and reforming – cyclical stability is a key criterion for more complex reactions to occur. Some of the amines present would reform into an amino acid (as occurs in industrial amine acid gas treatment systems)– this time within a protected structure. Having reformed within a protected structure an amino acid would survive and combine into peptides as opposed to being formed in free ocean water and being degraded from exposure to direct thermal energy from the hydrothermal vents. This model predicts the size of vesicles that could move about in a likely convection cell formed within typical porous solid structures found near hydrothermal vents, as well as the wall thickness of such a vesicle from heat transfer considerations – both predictions correspond extremely well with the sizes and cell wall thicknesses of the very early forms of living cells.