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Protolife Membrane Composition

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Introduction: A simpler membrane than those of current cells was likely present as a protective envelope for protolife. Using the same primordial conditions as have been demonstrated to form polypeptides, an amphiphilic substance comprised of only two precursor compounds likely present on primordial Earth can be formed by a condensation reaction [1]. Amphoteric lipoamino acids are readily synthesized in up to 50% yield when various amino acids and fatty acids are reacted under several different conditions: by heating in an inert atmosphere or by wet/dry cycling in inert atmosphere or even in air, particularly in the presence of a range of salts, minerals or clays. Similarly, when lauric (dodecanoic) acid was reacted with the dipeptide glycylglycine, a yield of 10% of lauroylglycylglycine was formed. Similar compounds in combination with cationic surfactants have been shown to form vesicles [2], to form micelles in dilute aqueous solutions and to form both hexagonal and cubic crystalline bilayer phases at higher concentrations [3,4]. Since lipoamino acids and lipopeptides lack glycerin, they avoid a prebiotic problem of early selection between the different chiralities found in archaeal compared to bacterial membrane lipids [5]. Also, since they do not contain phosphate, the need for early abstraction of phosphate from the environment is forestalled. Cells of current life forms lend credence to the early presence of these compounds: 1) lipopeptides and lipoamino acids are found in cells of both Bacteria and Eukarya [6,7]; 2) a lipopeptide has been found to replace membrane phospholipids in Bacteria raised in phosphate-depleted environments [8]; and 3) lipoamino acids and lipopeptides are synthesized by cells by means of non-ribosomal peptide synthetases [9], precluding the potential early need for RNA. Presence of amino acids and peptides at the surfaces of two-dimensional membranes would have provided catalytic surfaces on which various chemical reactions could have occurred. These results demonstrate that lipoamino acids and lipopeptides would have likely formed alongside peptides under the same prebiotic conditions, would have been likely components of a prebiotic membrane, and could have provided a variety of chemically active residues for chemical evolution.

Reaction Example:

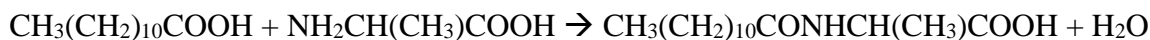


Figure 1 - Lauric acid + Alanine → Lauroylalanine + Water

References:

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