

RNA AND PROTEIN BUILDING BLOCKS STABILIZE AGGREGATES OF A PREBIOTIC AMPHIPHILE: A MECHANISM FOR THE CO-EVOLUTION OF COMPARTMENTALIZATION AND POLYMERS. Roy A. Black¹, Moshe T. Gordon², Matthew C. Blosser³, Benjamin L. Stottrup⁴, Ravi Tavakley^{4,5}, David W. Deamer⁶, and Sarah L. Keller³, ¹Dept. of Bioengineering, University of Washington, Seattle, Washington 98195 (royblack@comcast.net), ²Dept. of Chemistry, University of Washington, Seattle, Washington 98195, ³Depts. of Chemistry and Physics, University of Washington, Seattle, Washington 98195, ⁴Dept. of Physics, Augsburg College, Minneapolis, Minnesota 55454, ⁵College of Continuing Education, University of Minnesota, Minneapolis, Minnesota 55455, ⁶Dept. of Biomolecular Engineering, University of California-Santa Cruz, Santa Cruz, California 95064.

The required structures for cellular life are the two polymers, nucleic acid (e.g. RNA) and protein, surrounded by a membrane of amphiphilic molecules. We propose that these structures evolved from a self-assembled aggregate of amphiphiles, nucleobases, sugars, and amino acids. Since these building blocks would have been dispersed with other prebiotic compounds in early oceans, a major problem in understanding the origin of cells has been how the bases and the sugar of RNA and the amino acids of protein were selected, concentrated, and co-localized with membranes. It is also unclear how membranes were stabilized against flocculation in salt water. To address these questions, we explored the possibility that aggregates of decanoic acid, a prebiotic amphiphile that forms membranes, interact with nucleobases, sugars and amino acids [1]. We found that the RNA bases, as well as some but not all related bases, bind to decanoic acid aggregates. Moreover, both the bases and ribose (the sugar in RNA) inhibit flocculation of decanoic acid by salt. The inhibition by the bases correlates with the extent of their binding, ribose inhibits to a greater extent than three similar sugars, and the stabilizing effects of a base and ribose are additive. Turning to the building blocks of protein, we found that the two most hydrophobic prebiotic amino acids, leucine and isoleucine, prevent salt-induced flocculation. Moreover, although alanine and glycine, which are less hydrophobic, had little effect on flocculation, dipeptides composed of these amino acids preserved vesicles in the presence of salt at temperatures above which the flocs dissolve. These vesicles appeared to be primarily multilamellar structures, which may promote reactions between components of biopolymers more effectively than unilamellar vesicles. Thus, aggregates of a prebiotic amphiphile bind certain bases, sugars and amino acids. In turn, these compounds stabilize the aggregates against salt. These mutually reinforcing interactions between prebiotic membranes and components of RNA and protein could have driven the emergence of protocells.

Reference:

- [1] Black R.A., Blosser M.C., Stottrup B.L., Tavakley R., Deamer D.W. and Keller S.L. (2013) *PNAS* 110, 13272-13276..