Semi-Synthetic Minimal Cells

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In the last years, we have investigated lipid vesicles (liposomes) as cell models, by studying different aspects of their general reactivity, and their capability of hosting biochemical reactions.

Semi-synthetic minimal cells [1] are defined as liposome-based synthetic cells that contain the minimal and sufficient number of macromolecular components in order to be defined as "alive". Clearly, the design and the construction of minimal living cells require the establishment of the minimal number of life criteria. These have been generally described as self-maintenance, self-reproduction and evolution capability.

The current experimental approach to semi-synthetic minimal living cells exploits the combination between cell-free protein expression and liposome technology. We have recently investigated, within the SYNTHCELL project [2], the expression of functional proteins inside lipid vesicles by using a minimal set of enzymes, t-RNAs and ribosomes (PURESYSTEM) [3]. By this new approach, which goes in the direction of standardizing parts for synthetic cell construction, we have constructed lipid-synthesizing minimal cells by expressing for the first time functional membrane enzymes inside liposomes [4]. In addition, synthetic cells of very small size (i.e., 200 nm in diameter) have been recently investigated, at the aim of investigating experimentally the minimal size of viable cells [5].

In this contribution, we will discuss recent experimental and theoretical advancements in the field of synthetic cell constructions, giving emphasis to their relevance in synthetic biology and in origins of life studies.

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[5] Souza T, Stano P, Luisi PL (2009) The minimal size of liposome-based model cells brings about a remarkably enhanced biological activity. ChemBioChem, in press.