Synthesis and experimental evolution of a protocell

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The ability to evolve is a key characteristic that distinguishes living things from non-living chemical compounds. The construction of an evolvable cell-like system from non-living molecules has been a major challenge. Here we have constructed an evolvable protocell from an assembly of biochemical molecules. The biochemical molecules assembled into micro-scaled lipid vesicles or water-droplets in oil are the artificial genomic RNA and all the molecules required for protein synthesis and RNA replication. In the micro-compartments, the genetic information on the genomic RNA is translated into RNA replicase, which in turn that replicates the original genomic RNA.
After inner replication reaction of RNA, exhausting the nutrient molecules such as nucleic acids and so on, the compartments containing the replicated RNA were subjected to the fusion with other compartments containing the nutrients and the fission for proliferation in order to get ready for the next RNA replication reaction.

Using the translation-coupled RNA replication system, we performed an experimental evolution(600-generation), in which mutations were spontaneously introduced by the translated replicase into its genetic information, and highly replicable mutant RNAs dominated the population according to Darwinian principles. During the evolution, the genomic RNA gradually reinforced its interaction with the translated replicase, thereby acquiring competitiveness against the parasitic RNA. This study provides the first experimental evidence that a simple assembly of biomolecules in a cell-like compartment can autonomously develop their genetic code through Darwinian evolution. The recent progress toward synthetic cellular life will be updated.