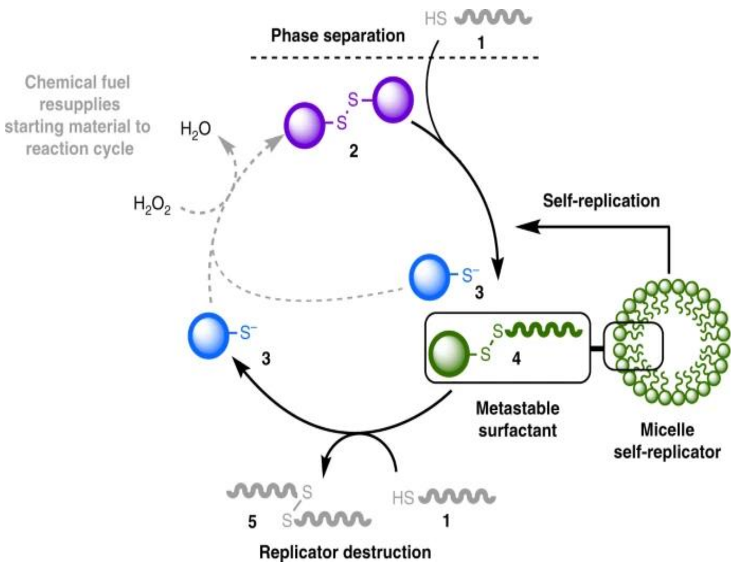
Article 13 - A chemically fuelled self-replicator

Morrow, S. M.; Colomer, I.; Fletcher, S. P. A Chemically Fuelled Self-Replicator. *Nature Communications* **2019**, *10* (1). https://doi.org/10.1038/s41467-019-08885-9.

Figure 2:



The chemically fueled self-replicator operates through a substrate cycle where two components (1 and 2) slowly react to form a waste product (3) and a surfactant (4). The surfactant aggregates into micelles, speeding up the reaction to produce more surfactant in a self-replicating process. However, surfactant 4 is also broken down into waste 3 and another product (5). In a closed system, this breakdown eventually destroys the surfactant. When an oxidizing fuel is added, it regenerates component 2 from waste 3, allowing the replicator to maintain itself in a steady, out-of-equilibrium state. This cycle consumes fuel and component 1 while keeping the intermediates stable, similar to cycles in biological systems. Once the fuel runs out, the system stops replicating and settles into equilibrium.

Synopsis:

In the 2019 study A Chemically Fuelled Self-Replicator, researchers Sarah M. Morrow, Ignacio Colomer, and Stephen P. Fletcher introduced a novel approach to creating self-replicating molecules powered by chemical energy. This advancement offers insights into the fundamental processes that could have led to the origin of life, as well as potential applications in synthetic biology and materials science.

The researchers developed a system where a chemical fuel drives a metabolic-like cycle, leading to the self-replication of specific molecules. This process mirrors simple metabolic pathways observed in biological systems, where energy is harnessed to drive chemical reactions that sustain life. In this system, the consumption of the chemical fuel maintains the replicators at a steady state, allowing them to persist and replicate over time. This continuous consumption of chemical energy powers the self-replicating molecules, enabling them to operate functional supramolecular structures.

A key figure in the article illustrates the substrate cycle of the chemically fuelled self-replicator. The figure shows the reaction between phase-separated components, highlighting how the consumption of the chemical fuel allows the high-energy replicators to persist in a steady state, much like a simple metabolic cycle.

This study's findings have significant implications for the field of synthetic biology. By demonstrating that chemical fueling can maintain systems of replicators out of equilibrium, the researchers reveal an important mechanism behind the molecular complexification of self-replicating systems. This approach could lead to the development of more complex self-replicating molecules, advancing our understanding of the origins of life and enabling the creation of artificial systems with self-replicating capabilities.

In summary, Morrow and colleagues' research provides valuable insights into the mechanisms of self-replication driven by chemical energy. Their work paves the way for future developments in synthetic biology and materials science, offering potential applications in creating adaptive and responsive systems.