Cellular Computation using Classifier Systems

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The EU FP6 Integrated Project PACE ("Programmable Artificial Cell Evolution") is investigating the creation, de novo, of chemical "protocells". These will be minimal "wetware" chemical systems integrating molecular information carriers, primitive energy conversion (metabolism) and containment (membrane). Ultimately they should be capable of autonomous reproduction, and be "programmable" to realise specific desired function. A key objective of PACE is to explore the application of such protocell technology to build novel nanoscale computational devices. Our contribution to this project is to investigate approaches to adding minimal computational capability to protocells.

We introduce the Molecular Classifier System (MCS) to represent the internal molecular reactions of the protocell. Reactions in the MCS are constrained as follows: The products of the reaction depend on the reactants and the environment in which the reaction took place; The reactions that can happen depend on the physical and chemical structure of the reacting compounds. In our MCS, there are reactants and reaction rules. The rules determine the reactants and the products for a given interaction.

These simple computational processes may also help in understanding the origins of Cell Signaling Networks(CSNs). CSNs are complex bio-chemical networks responsible for co-ordinating and controlling cellular activities. CSNs can therefore be regarded as computational systems. To understand the evolution of such complex computational systems as found in nature, we will distinguish the minimal computational properties fundamental for the survival of a protocell.