# ***Models for Origin of Life***

Objective: To give a presentation of about 60 minutes at the end of the week covering the key aspects of how to model the origin of life.

The origin of life (OoL) remains an elusive problem, although much progress has been made in recent years. Having gone from a problem considered beyond science to solvable in principle but maybe not in practice, many researchers now believe it will be solved in the next few decades. In fact, there are currently several OoL scenarios, but all still have some difficulties and lacunae to be overcome. The occurrence of an RNA world preceding DNA and proteins is generally considered to have been an important step in the origin of life. However, an RNA world spontaneously generating complex proteins and DNA still poses some unresolved problems. Moreover, and perhaps more importantly, the appearance of the RNA world itself is still mostly an open question.
It has been argued that a simple prebiotic metabolism could have generated the basic building blocks of life. This would have involved an autocatalytic cycle (such as the reverse citric acid cycle), i.e., a self-reinforcing cyclic arrangement of chemicals and reactions, each element responsible for producing the next one in the cycle. Although this idea is still debated, there is experimental evidence that simple (auto)catalytic networks could indeed have produced the basic ingredients for an RNA world. The appearance of proteins and then DNA (possibly from a precursor RNA world) is supported by arguments using ideas such as hypercycles, Darwin-Eigen cycles, or collectively autocatalytic sets. The claimed spontaneous appearance of autocatalytic sets has been disputed, but there is some evidence that they could be constructed experimentally. Summarizing the above story, a plausible scenario for the origin of life that has recently emerged is as follows: (In)organic chemistry ) Prebiotic metabolism ) RNA world ) Proteins ) DNA. Although none of these steps have (yet) been proven beyond any doubt, they are at least plausible, and there is evidence (theoretical and/or experimental) to support them.
The origin of life on earth is still in search of a satisfactory explanation. The field is dominated by many facets and partial explanations. Facets include frequency of planetary systems, climatology of early earth, chirality in naturally occurring compounds, abiotic production of molecules, etc. Partial explanations include the naturally occurring self-reproducing molecules, quasispecies and hypercycles, an RNA world, natural formation of micelles, etc. However, most of these explanations are incomplete or based on speculation. This project tries to discuss different formal models for the origin of life.

***The Big Questions Are:***

How could the origin of life problem be solved?
What are the main present challenges in solving this?
What can be learnt from models of origin of life
Which properties must such models have?

***Possible Contents of Presentation/report***

The History of Origins of Life Research
History of Models in Origin of Life Research
The Key Models.
The Key Challenges in Origin of Life Research

***Possible starting points***

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Ganti, T (1997) Biogenesis itself. *Journal of Theoretical Biology* 187, pp. 583-593, 1997.
Hordijk and Steel (2004) Detecting autocatalytic, self-sustaining sets in chemical reaction systems. *J. Theor Biology* 227(4), pp. 451-461,
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Steel. The emergence of a self-catalysing structure in abstract origin-of-life models. *Applied Mathematics Letters* 3, pp.91-95, 2000.
Von Neumann. *Self-reproducing automata*. 1967.