

A review of one approach to bottom up assembly of minimal life

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Abstract

When seeking to assemble minimal life from the bottom up in wet carbon chemistry, the critical properties of life apparently emerge from the interconnected functions of three subsystems: information, metabolism and container. Such interconnected supramolecular systems, so-called protocells, are under the right circumstances able to mimic the main functions of a living cell although in a very simplified manner¹.

Seeking to create minimal life from the top down leads us to a somewhat different picture, where construction of synthetic / streamlined genomes become the critical scientific issue^{2,3}. How to integrate the knowledge we obtain from the top down- and the bottom up approaches is a great challenge for our and related communities^{4,5} and a good problem to discuss at this meeting.

In technical terms, our bottom up team explores ruthenium-based photocatalysis as metabolism, fatty acids vesicles, oil droplets and reverse micelles as containers and lipophilic XNA as minimal informational systems^{6,7}. Based on our experimental, computational and theoretical work we review protocell feeding, growth, division, motility, and information controlled metabolic production of containers^{8,9,10,11}.

Finally, we demonstrate preliminary integration of biochemical- and microelectromechanical (MEMS) systems where life-like information processing and material production occur and interact in different media^{12,13} and as such form an exciting frontier for the study of artificial life.

¹ Rasmussen S, et al., *Protocells: Bridging nonliving & living matter*, MIT Press, 2009

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⁴ Sunami T, et al., (2010) Detection of association and fusion of giant vesicles using a fluorescence-activated cell sorter, *Langmuir* 26: 15098

⁵ Porcar M, et al., (2011), Ten grand challenges for synthetic life, to appear in *Synthetic Biology*.

⁶ Rasmussen S, et al., (2003) Bridging nonliving and living matter, *Artificial Life* 9; 269

⁷ Rasmussen S, et al., (2004) Transitions from nonliving to living matter, *Science* 303: 963

⁸ Fellermann H, et al., (2007) Life-cycle of a minimal protocell – A dissipative particle dynamics study, *Artificial Life* 13; 319

⁹ DeClue M, et al., (2009) Nucleobase mediated, photocatalytic vesicle formation from ester precursor molecules, *JACS* 131 931

¹⁰ Toyota T, et al., (2009) Self-propelled oil droplets consuming “fuel” surfactant. *JACS*

¹¹ Maurer S, et al., (2011) Interactions between catalysts and amphiphilic structures and the implications for a protocell model. *Chem Phys Chem* 12; 828

¹² <http://www.fp7-matchit.eu>

¹³ McCaskill, p. 253, in *Protocells: Bridging nonliving & living matter*, eds Rasmussen S, et al., MIT Press, 2009