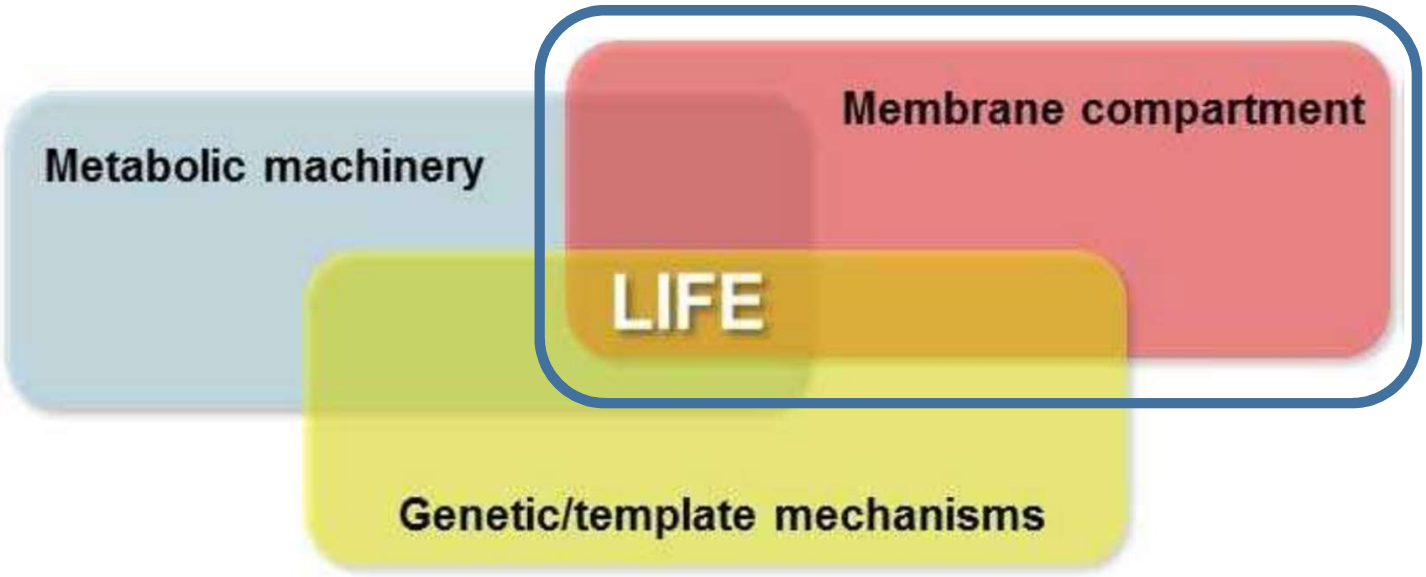
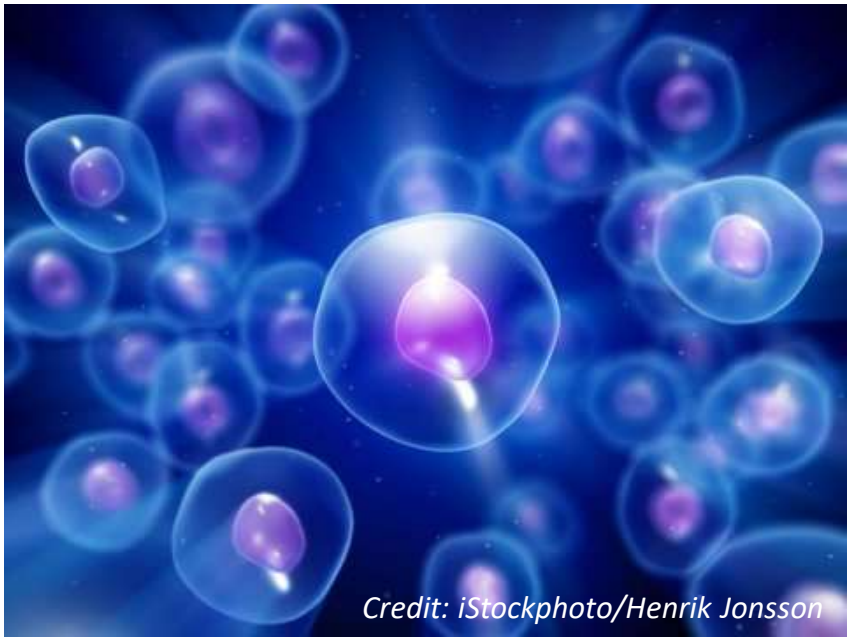
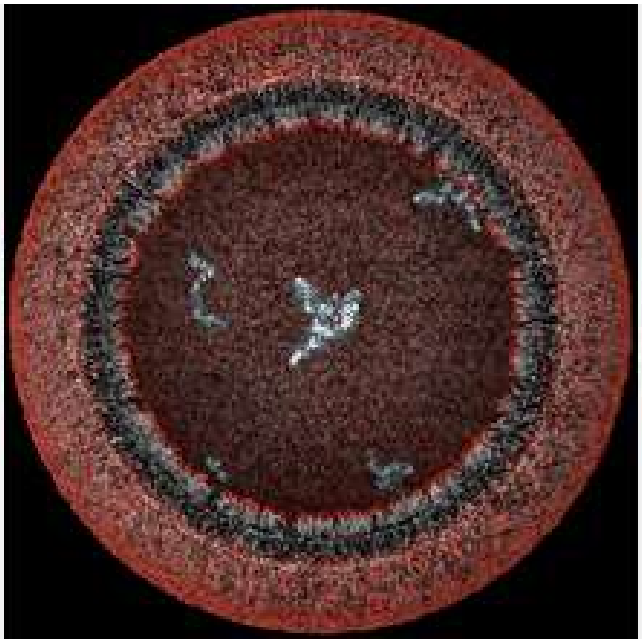

Membrane compartment
Metabolic machinery
LIFE
Genetic/template mechanisms

Encapsulation – essential for life



Membrane compartments

Assembly of amphiphilic monomers into protocellular compartments

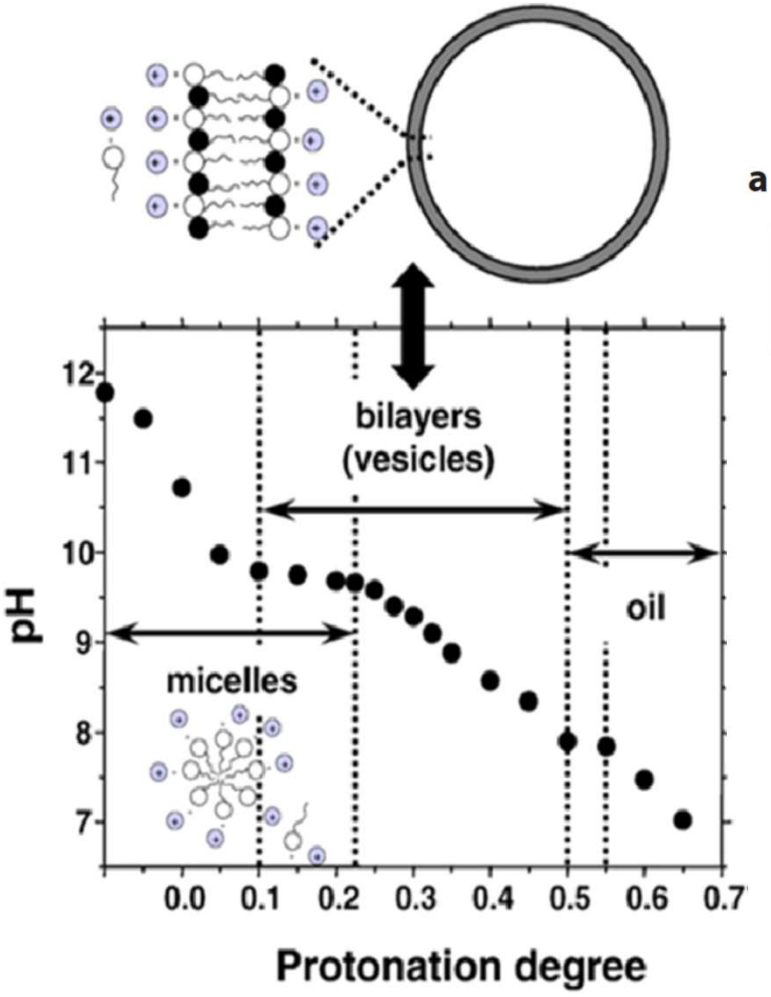


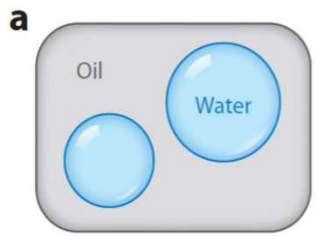
Credit: *Janet Iwasa*

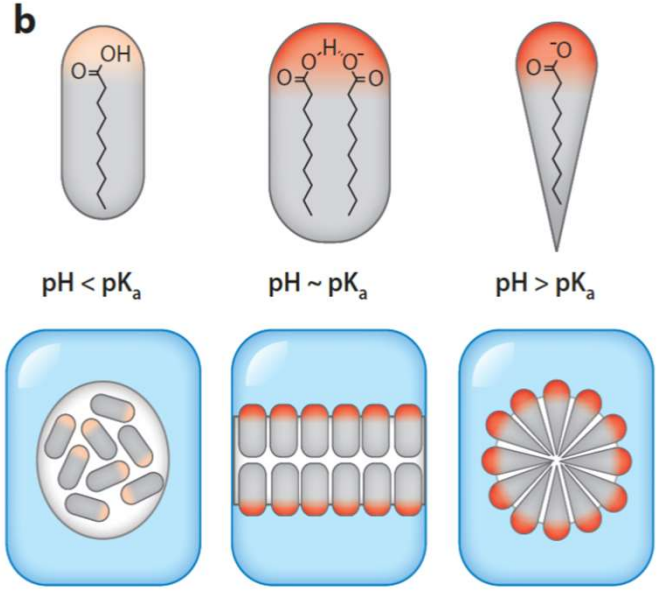
A three-dimensional view of a model protocell (a primitive cell) approximately 100 nanometers in diameter.

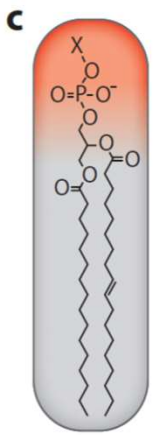
The protocell's fatty acid membrane allows nutrients and DNA building blocks to enter the cell and participate in non-enzymatic copying of the cell's DNA. The newly formed strands of DNA remain in the protocell

pH-dependent phase behavior of fatty acids in water



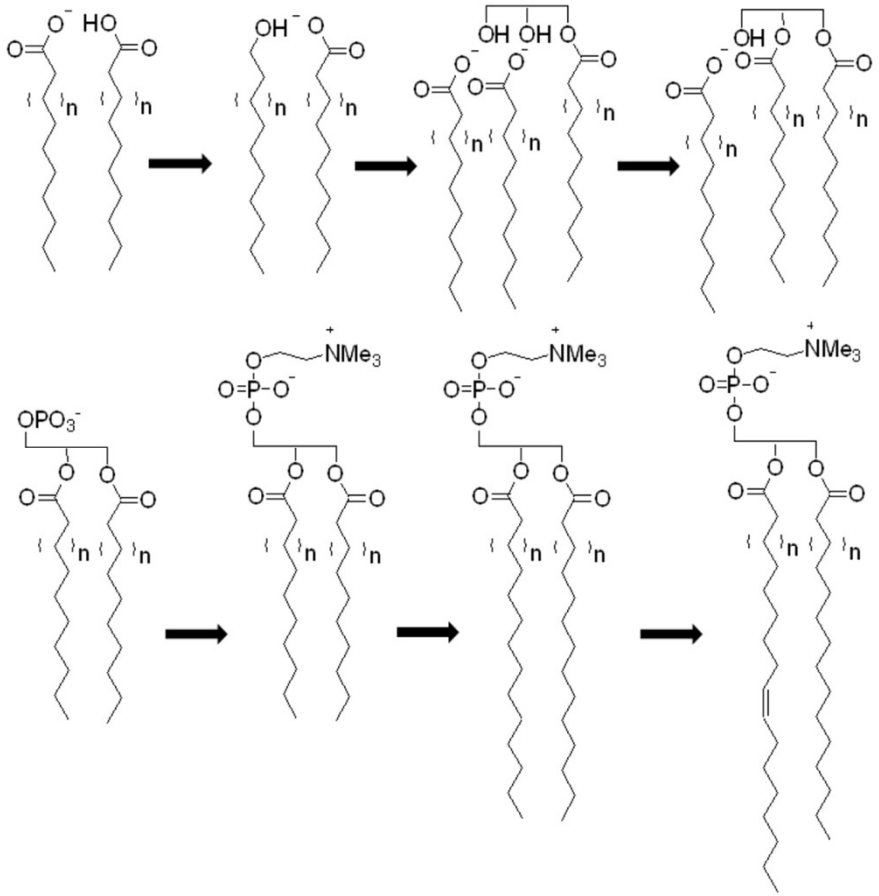




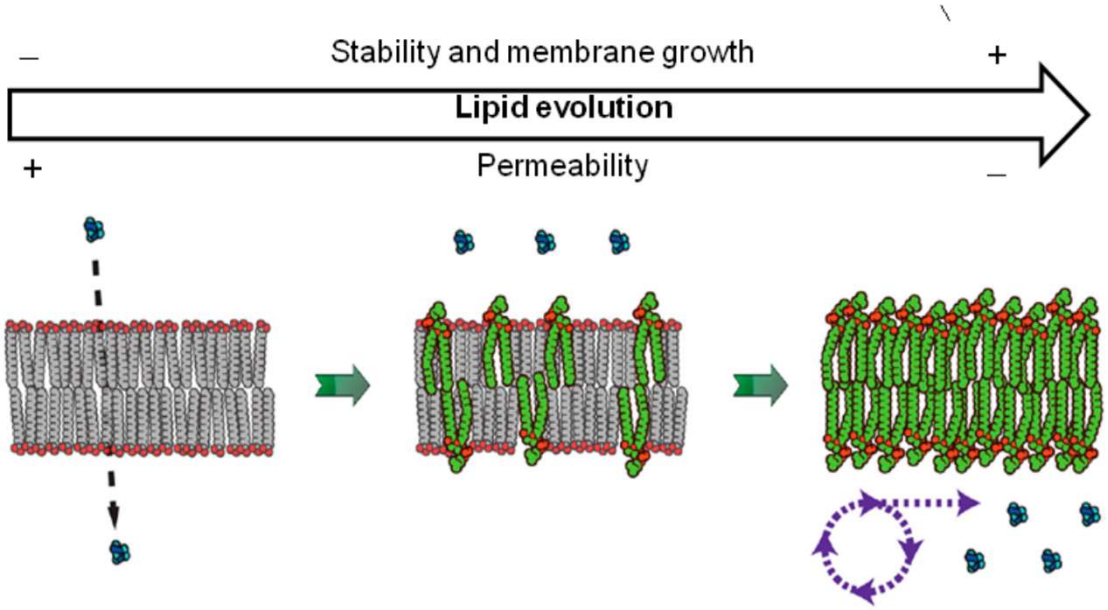


80 mM oleic acid/ sodium oleate in water

Scheme of the membrane evolution

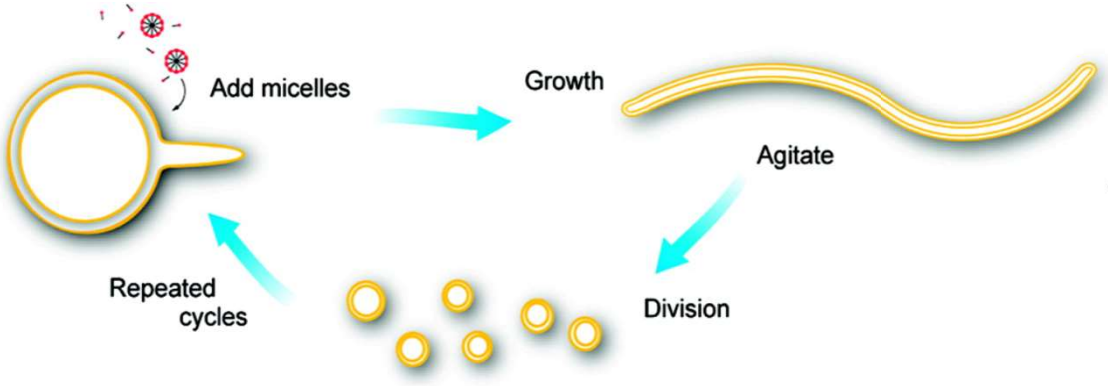


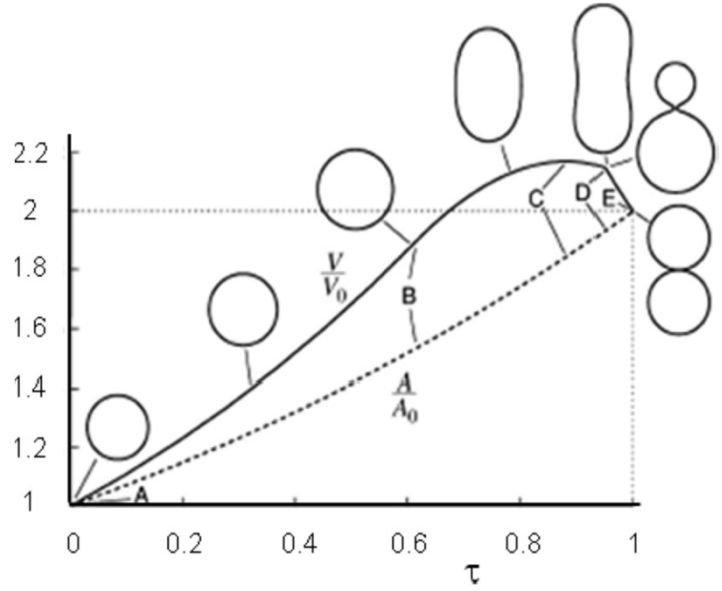
Chemical evolution of membrane components



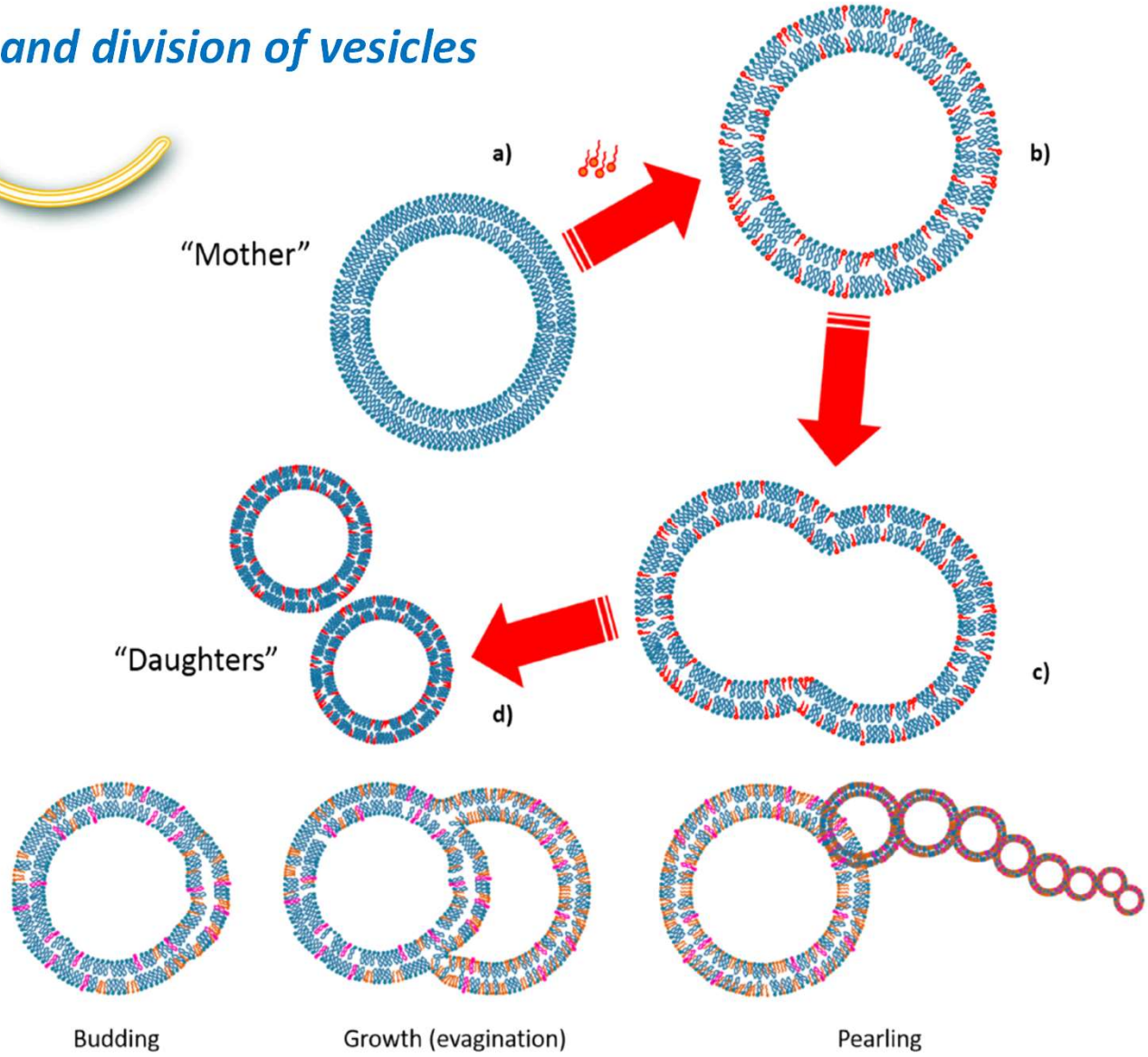
More complex components lead to slower amphiphile desorption and thus faster growth of the protocell. Decreasing permeability is a selective pressure for the emergence of internalized metabolic and transport machinery in the system

Growth and division of vesicles



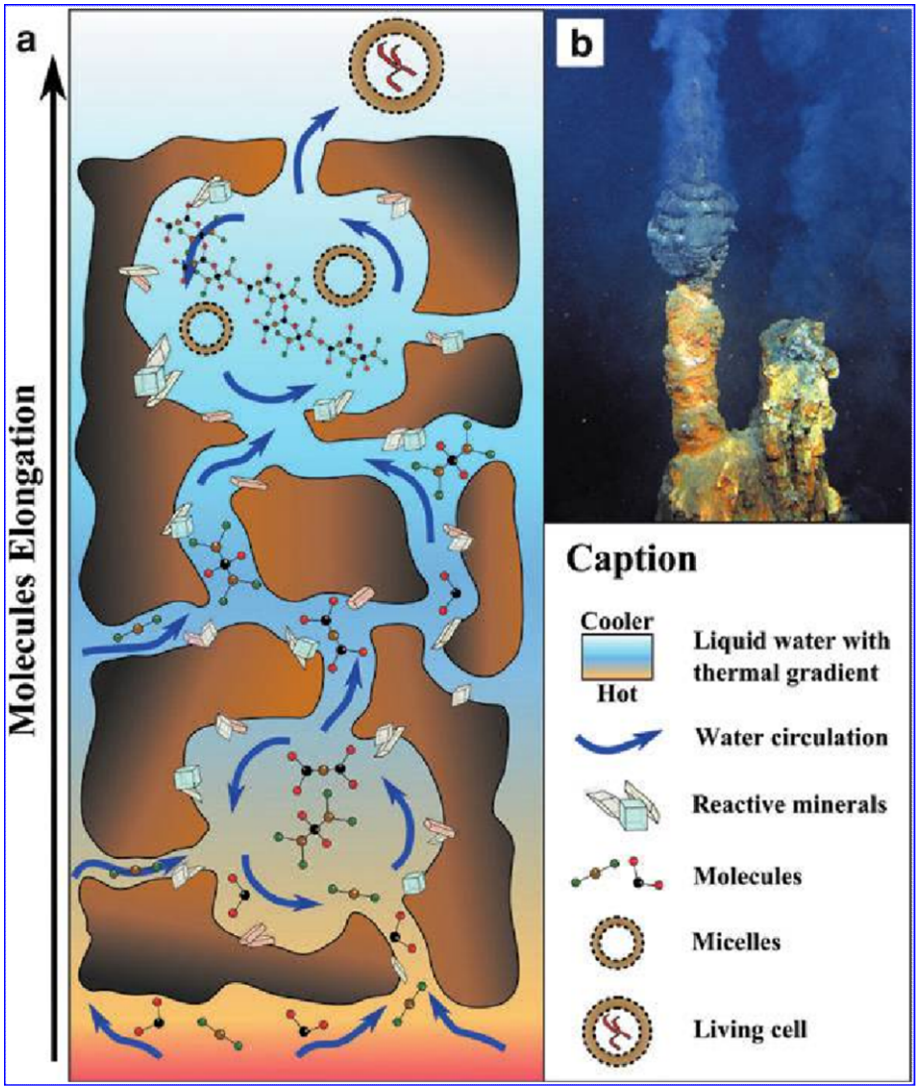


Ting F. Zhu, and Jack W. Szostak
J. Am. Chem. Soc., **2009**, 131 (15), 5705-5713



A. Lopez, M. Fiore *Life* **2019**, 9(49), doi:10.3390/life9020049

Deep sea vent origin of life



Possible origin of life in porous hydrothermal vents.

(a) Sketch showing a porous beehive structure where hydrothermal fluids and seawater can circulate, leading to the accumulation of organic molecules. The reduced mineral surfaces within the vent pores could be favorable locations for the structural organization of macromolecules. We hypothesize the formation of lipid micelles in these environments and the incorporation of information-transferring molecules within the micelles, perhaps due to moderate agitation of the hydrothermal effluent.

(b) Image of a modern black smoker

(image credit: National Oceanographic and Atmospheric Administration). Color images available online at www.liebertonline.com/ast

F. Westall et al., *Astrobiology* **2013**, *13(9)*, 887-897