Contents

Theme issue: Re-conceptualizing the origins of life

INTRODUCTION
Re-conceptualizing the origins of life
SI Walker, N Packard and GD Cody

ARTICLES
Universal biology and the statistical mechanics of early life
N Goldenfeld, T Biancalani and F Jafarpour

Life as an emergent phenomenon: studies from a large-scale boid simulation and web data
T Ikegami, Y Mototake, S Kobori, M Oka and Y Hashimoto

Origin of life in a digital microcosm
NC, T LaBar, A Hintze and C Adami

A probabilistic framework for identifying biosignatures using Pathway Complexity
SM Marshall, ARG Murray and L Cronin

How causal analysis can reveal autonomy in models of biological systems
W Marshall, H Kim, SI Walker, G Tononi and L Albantakis

Coarse-graining as a downward causation mechanism
JC Flack

The thermodynamic efficiency of computations made in cells across the range of life
CP Kempes, D Wolpert, Z Cohen and J Pérez-Mercader

An intermediate level of abstraction for computational systems chemistry
JL Andersen, C Flamm, D Merkle and PF Stadler

Exploring astrobiology using *in silico* molecular structure generation
M Meringer and HJ Cleaves

Bulk measurements of messy chemistries are needed for a theory of the origins of life
N Guttenberg, NVirgo, K Chandru, C Scharf and I Mamajanov

Subsumed complexity: abiogenesis as a by-product of complex energy transduction
ZR Adam, D Zubarev, MAono and HJ Cleaves

Protoenzymes: the case of hyperbranched polyesters
IMamajanov and GD Cody

Expanding the informational chemistries of life: peptide/RNA networks
OTaran, CChen, TOMosun, M–CHsieh, ARha, JT Goodwin, AKMehta, MAGrover and DGLynn

Conceptualizing the origin of life in terms of evolution
NTakeuchi, PHogeweg and K Kaneko

Resurrecting ancestral genes in bacteria to interpret ancient biosignatures
BKacar, LGuy, ESmith and JB Baross

The role of public goods in planetary evolution
JOMcInerney and DHErwin

Chance, necessity and the origins of life: a physical sciences perspective
RMHazen