Chemical evolution of RNA and proteins to the primitive life-like system on the basis of the two-gene hypothesis of origin-of-life

Kunio Kawamura, Yoshimi Maruoka, Noriko Konagaya

Introduction

Here, we focus on two main drawbacks regarding the chemical evolution of RNA and protein-like molecules. First, compatibility between chemical evolution experiments and the Hadean Earth environments is an important point for considering the mechanism of the emergence of life on the Earth [1]. Although many types of simulation experiments have been carried out under the specific selected experimental conditions, the conditions are not sufficiently evaluated from the viewpoint whether such environments likely existed. Especially, a consecutive chemical evolution from simple to complicated organic molecules should have been necessary. However, for instance, suitable environments for the formation of nucleotide bases and that of nucleosides and nucleotides seem to hardly match [2]. In addition, the Hadean environments were speculated much more extreme as compared to the present Earth environments for modern organisms. We have developed several types of hydrothermal reaction tools for investigations of such chemical evolution processes under the hydrothermal conditions [3]. We describe the chemical evolution of RNA and protein-like molecules evaluated using these experimental tools. These results suggest that the accumulation of oligopeptides should have been much easier than that of RNA.

Two-gene hypothesis

Second, it is unclear how the accumulation of simple RNA molecules could have evolved to a higher stage, which can be called alive. Although ribozymes including the RNA-dependent RNA polymerase ribozyme (RRP-ribozyme) were essential towards RNA-based life-like systems, this seems to be not sufficient. We proposed that 2 genes including the gene of the RRP-ribozyme and that for enhancing the primitive metabolic cycle of RNA were necessary to initiate the chemical evolution towards an RNA-based life-like system [4]. According to these studies, we attempt to summarize possible a scenario from simple building blocks to the life-like system.

This study was supported by Hiroshima Shudo University Grant 2018.

[1] Kawamura & Maurel (2017) *OLEB* **47**, 281-296. [2] Kawamura, Konagaya, & Maruoka (2018) *Astrobiology* **18**, 1403-1413. [3] Kawamura (2011) Anal. Sci. 27, 675-683. [4] Kawamura (2016) *Life* **6**, 29.