Artificial Cell Models Exhibiting Self-reproducing and Self-replication Dynamics and Spontaneous Movements

T. Sugawara, S. Shohda, K. Takakura, K. Suzuki, T. Toyota,
Y. Kageyama, N. Maru, K. Kurihara, H. Takahashi, and M. Tamura
The University of Tokyo, Japan

1. INTRODUCTION

In order to answer such profound questions as “From where has a life come?” “Where is a boundary between animate and inanimate objects?” a constructive approach is effective. We have constructed minimal cell models using well-defined organic molecules and bio-polymers and studied the non-linear dynamics. It turns out that some of them exhibit self-reproducing, self-replicating, and others dynamics show spontaneous movement, respectively.

2. SELF-REPRODUCING SYSTEM COMPOSED OF GIANT VESICLES

We have observed following self-reproducing dynamics exhibited by giant vesicles (GVs). [1] i) When a bolaamphiphilic membrane-precursor is added to giant vesicles containing a catalyst, ii) The membrane precursor is hydrolyzed to give same membrane molecule as the original GVs, iii) Increase of the membrane molecules causes corpulence of GVs, iv) As a result, corpulent GVs self-divide into two GVs with the same composition. When the self-reproducing dynamics was traced by flow cytometry, we found that the self-reproducing continues through several generations, keeping the similar size-distribution of the original. [2]

3. SELF-REPLICATION OF INFORMATIONAL MOLECULES INSIDE GIANT VESICLES

We conducted polymerase chain reaction (PCR) of DNA using a template DNA consisted of *ca.*1200 base pairs and confirmed self-replication by SYBR Green I (fluorescent probe that emits green light when hybridized with duplicated DNA) and polyacrylamide gel electrophoresis. [3] Complementary self-replication of a template was also carried out on the surface of the outmost membrane of GV using a conjugate molecule made of a cholesterol-spacer-DNA 15mer. [4]

4. SELF-REWINDING HELIX AND SPONTANEOUSLY PROPELLING OIL DROPLET MADE OF SOFT MATTER

Another characteristic feature of a cell is “movement”. Such movement is driven by chemical energy acquired by hydrolysis of ATP. We found self-winding helix [5] and self-propelling oil droplet [6] made of soft matter by chance. It would be “soft matter” that connects animate and inanimate objects.

REFERENCES

1. Takakura, K., Sugawara, T., *Langmuir*, **20**, 3832–3834, (2004).
2. Toyota, T., Takakura, K., Kageyama, Y., Kurihara, K., Maru, N., Ohnuma, K., Kaneko, K., Sugawara, T., *Langmuir*, (2008), *in press*.
3. Tamura, M., Kageyama, Y., Shohda, K., Suzuki, K., Sugawara, T., *to be published*.
4. Shohda, K., Sugawara, T., *Soft Matter*, **2**, 402–408, (2006).
5. Ishimaru, M., Toyota, T., Takakura, K., Sugawara, T., Sugawara, Y., *Chem. Lett.*, **34**, 46–47, (2005).
6. Hanczyc, M. M., Toyota, Y., Ikegami, T., Parkard, N., Sugawara, T. *J. Am. Chem. Soc.*, **129**, 9386–9391, (2007).