PRESS RELEASE

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Subject line: Formation of Artificial Cells with a Skeletal Support Reinforcement to withstand Application Realized

A research group of Tokyo University of Agriculture and Technology, Tokyo Institute of Technology, Keio University and Tohoku University have successfully developed an artificial cytoskeletal structure for cell models (liposomes[1] or artificial cells) using DNA nanotechnology[2], and demonstrated that liposomes with the cytoskeletal structure were almost as strong as living cells.

Liposomes have been used as a material in many common products such as capsules for drug delivery and cosmetics. However, the membrane is fragile, leading to problems such as collapse of liposomes by slight stimulus, causing the entrapped compounds to easily leak. To improve the function of liposome as a capsule, it has been needed to develop a method that can toughen liposomes and control their strength.

In order to increase the strength of liposomes, Miho Yanagisawa at Tokyo University of Agriculture and Technology, Masahiro Takinoue at Tokyo Institute of Technology, and their colleagues developed a network structure of DNA that supported membranes similar to a cytoskeleton in living cells using DNA nanotechnology (Figure 1A). The DNA strands used in this study bind to each other and create a network structure by decreasing temperature (Figure 1B). Also, since DNA has negative electric charge, using the attractive force between DNA and the inner layer of liposome with positive charge, they succeeded in forming a DNA cytoskeleton that directly supported the liposome membrane as backing. Liposomes are generally easy to collapse even when a slight osmotic pressure was applied to liposomes. In contrast, liposomes with the DNA cytoskeleton they developed were tolerant of an osmotic pressure even when the applied osmotic pressure was comparable to that assumed to be applied in our body (Figure 2). This reinforcement function is derived from the network structure of DNA; also, there is an advantage that the strength of the DNA cytoskeleton can be control by the DNA base sequence design. In addition, since the artificial cytoskeleton is formed using DNA, it is expected to impart various functions such as induction of membrane collapse based on DNA chemical reactions for controlled release of entrapped compounds.

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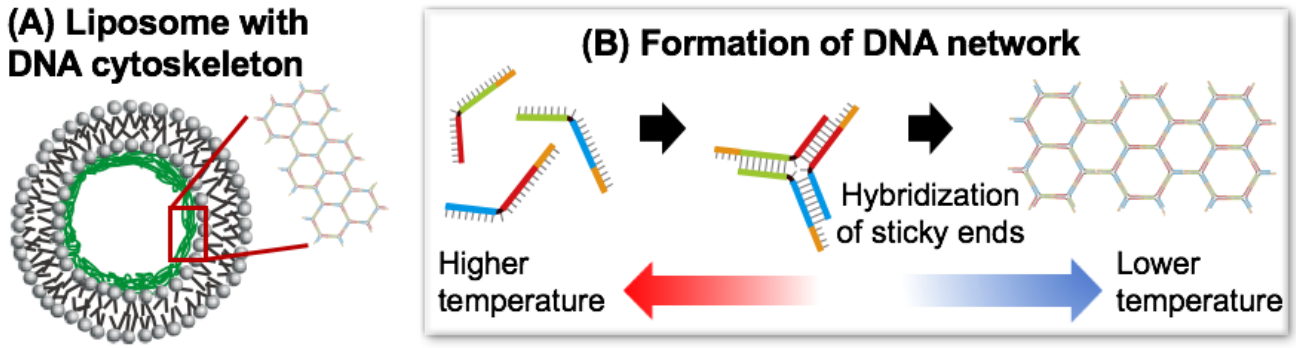

Figure. 1 Schematic illustration of this work. (A) The illustration of the cross section of a liposome with DNA skeletal structure. (B) Schematic diagram showing the DNA network formation.

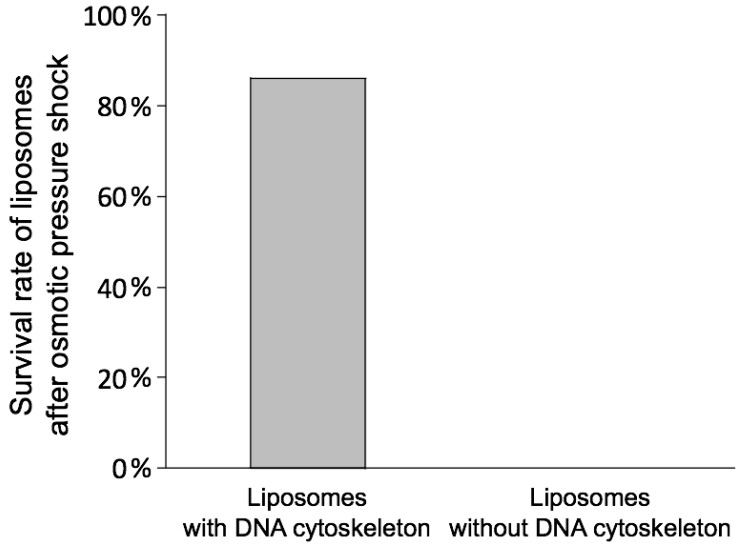

Figure 2: Survival rates of liposomes after osmotic pressure shock when the osmotic pressure is applied to liposomes with the DNA skeleton (left) and without it (right).

Technical term

1) Liposome: An artificial lipid bilayer membrane vesicle mainly composed of lipids. It is used in various fields such as modeling of cell membranes, drug delivery, and cosmetics.

2) DNA nanotechnology: A technology to create nanometer-sized (1/1,000,000th of a millimeter) structures in a controlled manner by utilizing the nature of double helix formation of DNA. In this study, the network structure created by DNA was produced and utilized for the construction of an artificial cytoskeleton.

Reference

Chikako KUROKAWA[a], Kei FUJIWARA[b], Masamune MORITA[c], Ibuki KAWAMATA[d], Yui KAWAGISHI[d], Atsushi SAKAI[a], Yoshihiro MURAYAMA[a], Shin-ichiro M. NOMURA[d], Satoshi MURATA[d], Masahiro TAKINOUE[c,*], Miho YANAGISAWA [a,*], DNA cytoskeleton for stabilizing artificial cells, *Proceedings of the National Academy of Sciences of the United States of America,* DOI:10.1073/pnas.1702208114.

Affiliations:

[a] Department of Applied Physics, Tokyo University of Agriculture and Technology

[b] Department of Biosciences and Informatics, Keio University

[c] Department of Computer Science, Tokyo Institute of Technology

[d] Department of Robotics, Tohoku University

Science Contacts

Associate Professor Miho Yanagisawa
Division of Advanced Applied Physics, Institute of Engineering,
Tokyo University of Agriculture and Technology
E-mail : myanagi@cc.tuat.ac.jp
Tel:81-42-388-7113

Associate Professor Masahiro Takinoue
Department of Computer Science, School of Computing,
Tokyo Institute of Technology
E-mail : takinoue@c.titech.ac.jp
Tel: 81-45-924-5654

Assistant Professor Kei Fujiwara
Department of Biosciences and Informatics,
Faculty of Science and Technology,
Keio University
E-mail : fujiwara@bio.keio.ac.jp
Tel: 81-45-566-1533

Professor Satoshi Murata
Department of Robotics,
Graduate School of Engineering,
Tohoku University
E-mail: murata@molbot.mech.tohoku.ac.jp
Tel: +81-22-795-4100

Press contact
Emiko Kawaguchi
Public Relations Section,
Tokyo Institute of Technology
E-mail: media@jim.titech.ac.jp
Tel: +81-3-5734-2975