20151023 wiki(Project)\_JamboreeVer8.0

2015年10月22日

11:43

Background

Many proteins are known to function in multimeric configuration. For instance, Trp RNA-Binding Attenuation Protein(TRAP) [1] and GTPase [2] assemble circular structures while Tetratricopeptite – repeat Protein (TRP) [3] assembles a linear structure.

|  |
| --- |
|  |
| Fig. 1 Assembly of multimeric proteins |

In case of cicular configuration, proteins have intrinsic curvature and the number of monomers are determined by the angle of a monomer. However, most of linear assembly like the fiber or string of proteins grow unlimitedly. Controlling the number of linear assembly is difficult without additional capping mechanism [4-5]. Here, we focused on constructing **size-controllable linear homomultimer** by DNA origami. We proposed a novel mechanism to control the linear assembly.

Conventionally, DNA nanostructure such as DNA tile utilizes the hybridization between complementary base sequences [6-7]. In contrast, we propose a method which directly utilizes shape-complementary DNA origami structures to construct various multimeric complexes [8].

Project Idea

In our project, we have designed a DNA origami monomer consisting of a cylinder and a twisted shaft, where the shaft can rotate inside the cylinder. The shaft works as a vernier to count the number of stacked monomer and grooves on the cylinder limits the movement of the shaft that determines the number of stacking. Furthermore, by adjusting the twist angle of the shaft and the groove width of the cylinder, we can change the number.

|  |
| --- |
|  |
| Fig. 2 The concept of our idea |

Project Goal & Project Achievement

|  |
| --- |
|  |
| Fig. 3 The goal and the achievement of our project |

Our goal is to realize the linear homomultimer which is able to control the number of stacking. We divide the goal into 5 sub-goals.

* To design the monomer with the vernier mechanism.
* To simulate the stacking behavior using physical engine.
* To confirm the shape of the DNA origami monomer by experiment.
* To verify the stacking of monomers by experiment.
* To evaluate the stacking control mechanism.

Actually, we have achieved all sub-goals now. The designed DNA origami monomer is constructed correctly. The monomers stack to form multimer as we confirmed the functionality of proposed vernier mechanism.

Reference

[1] Bayfield, O. W., Chen, C. S., Patterson, A. R., Luan, W., Smits, C., Gollnick, P., & Antson, A. A. (2012). Trp RNA-binding attenuation protein: modifying symmetry and stability of a circular oligomer. PloS one, 7(9), e44309.

[2] Shin, D. H., Lou, Y., Jancarik, J., Yokota, H., Kim, R., & Kim, S. H. (2004). Crystal structure of YjeQ from Thermotoga maritima contains a circularly permuted GTPase domain. Proceedings of the National Academy of Sciences of the United States of America, 101(36), 13198-13203.

[3] Kajander, T., Cortajarena, A. L., Mochrie, S., & Regan, L. (2007). Structure and stability of designed TPR protein superhelices: unusual crystal packing and implications for natural TPR proteins. Acta Crystallographica Section D: Biological Crystallography, 63(7), 800-811.

[4] Sara H. Mejías, et al. "Controlled nanometric fibers of self-assembled designed protein scaffolds." Nanoscale 6.19 (2014): 10982-10988.

[5] Matsunaga, R., Yanaka, S., Nagatoishi, S., and Tsumoto, K. "Hyperthin nanochains composed of self-polymerizing protein shackles." Nature communications 4 (2013).

[6] Hamada, S., and Murata S. "Substrate‐Assisted Assembly of Interconnected Single‐Duplex DNA Nanostructures." Angewandte Chemie 121.37 (2009): 6952-6955.

[7] Winfree, E., Liu, F., Wenzler, L. A., and Seeman, N. C. "Design and self-assembly of two-dimensional DNA crystals." Nature 394.6693 (1998): 539-544.

[8] Gerling, T., Wagenbauer, K. F., Neuner, A. M., and Dietz, H. "Dynamic DNA devices and assemblies formed by shape-complementary, non–base pairing 3D components." Science 347.6229 (2015): 1446-1452.