【Grant-in-Aid for Scientific Research(S)】

Integrated Disciplines (Complex systems)

Title of Project : Creation of Biomaterials Endowed with Unique Properties of DNA Soft-Interfaces

Mizuo Maeda
(RIKEN, Bioengineering Laboratory, Chief Scientist)

Research Area : Biomaterials
Keyword : Nucleic Acid, Cell, Biomaterial, Gel, Soft-interface

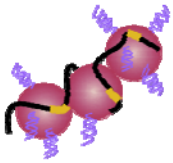
【Purpose and Background of the Research】

The project aims to develop biomaterials using unique properties of DNA brushes (DNA soft-interfaces). We have demonstrated that the colloidal stability of the nanoparticles (NPs) having a double-stranded (ds) DNA soft-interface increases as decreasing thermodynamic stability of the terminal base pair. When complementary DNA is added to the dispersion of DNA–NPs to form the fully matched dsDNA, the NPs spontaneously aggregate in a non-crosslinking manner. In contrast, the dsDNA–NPs acquire high stability to disperse even in a high ionic-strength medium when a terminal mismatch exists at the interface between the dsDNA shell and water. This observation suggests that using small DNA (10–20 bases) as a surface modifier will allow us to regulate the properties of the materials by changing the terminal base pairs. We will verify this hypothesis by conducting the following three research topics.

【Research Methods】

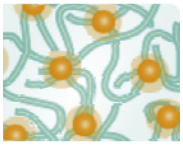
Structural changes of DNA-nanorods

One-dimensional arrays of DNA–gold NPs at regular intervals on a long DNA template are prepared. A dynamic change from such a beads-on-a-string structure into a rod-like one will be demonstrated by utilizing non-crosslinking aggregation of aligned dsDNA–gold NPs. This pseudo-nanorod will find various applications including gene carriers and structural models of chromatin.



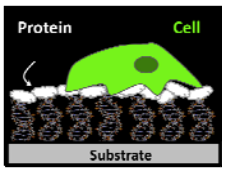
DNA-gels exhibiting stimuli-responses

Non-crosslinking aggregation of NPs is triggered within hydrogels to produce macroscopic responses such as volume changes. The gels are prepared through hybridization of DNA–NPs and DNA-grafted polymers. This responsiveness should be useful to develop biosensors and drug carriers.



Cell-culturing substrates with DNA layers

Interactions are investigated between DNA soft-interfaces and proteins. We will elucidate a relationship between the structure of the terminal base pair and the degree of protein adsorption to design novel cell-culturing substrates with the DNA soft-interfaces. In addition, we will develop new DNA soft-interfaces whose surface properties can undergo drastic changes in response to stimuli, thereby constructing non-invasive cell harvesting systems.



【Expected Research Achievements and Scientific Significance】

Applications of the DNA soft-interfaces have been limited to the realm of analytical science and diagnostics. In this project, we will demonstrate the usefulness of the DNA soft-interfaces in the biomaterials field. Integrating analytical and materials sciences concerning the DNA soft-interfaces, we might possibly establish a new research area, “DNA interface engineering.” This emerging field should serve to further widen scientific avenues connecting bioconjugate chemistry, soft matter physics, cell biology, and nanotechnology.

【Publications Relevant to the Project】

1) K. Sato et al., *J. Am. Chem. Soc.* **2003**, *125*, 8102.
2) J. Nakanishi et al., *J. Am. Chem. Soc.* **2007**, *129*, 6694.
3) K. Suzuki et al., *J. Am. Chem. Soc.* **2009**, *131*, 7518.

【Term of Project】 FY2013-2017

【Budget Allocation】 165,900 Thousand Yen

【Homepage Address and Other Contact Information】

http:// www.riken.jp/lab-www/bioengineering/