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Challenges of Bio-Nanotechnology

Bio-nanotechnology has been successful in leading us to a deep insight of the biological information world of a living cell that contains a whole set of molecular information networks including signal transducing and gene information networks. In response to a change of surrounding conditions, an input signal is transduced at a cell membrane and processed through the intracellular information networks with resulting in modulation of biological activities such as gene expression, protein production, and differentiation. Single molecule imaging is one of breakthroughs to unveil the individual molecule level of mechanisms of intracellular information processes. The key issue is that biological information is processed through a “Nano-structure Change”; rotation, transition, bending, and conformation change, when the input signal reaches. These findings open a door to the biological information world, which may encourage us to endeavor the new frontiers.



There have been emerging challenges in bio-nanotechnology, which are featured by bio-devices and bio-systems based on biological information, for medical use. Single molecule bio-devices and bio-systems are exciting challenges. Various DNA bio-devices have been developed for direct gene diagnosis, screening gene regulating factors, and drug discovery, Novel bio-systems have been designed for protein factory by implementation of ribosomes and virus nano-particles.

Promising challenges have also been emerging in designing cellular bio-devices. The developments are strongly supported by the bio-nanotechnology progress of the cellular responses to physical stimuli. We found that the intracellular information is electrically modulated. As an example, when cells are stimulated by a low frequency of alternative potential, the gene expressions are activated [1]. Electrically responsive genes have been screened-out. The biological activity is controlled by electric stimulation to a living cell. These findings have been extended to develop cellular bio-devices for pancreas alternative, on demand drug delivery, and safety check of chemicals as animal test alternative.

References

- 1) S. Koyama, E. Kobatake, and M. Aizawa, *Nature Biotech.* 15, 164 (1997).