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Single Molecule Imaging and Nanometry: Fluctuation and Function of Life



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ABSTRACT: Since biological molecular machines such as molecular motors, cell signal processors, DNA transcription processors and protein synthesizers are only nanometers in size and have a flexible structure, they are very prone to thermal agitation. Furthermore, the input energy level is not much different from that of average thermal energy, $k_B T$. Molecular machines can use this thermal noise with a high efficiency of energy conversion for their functions. This is in sharp contrast to man-made machines that operate at energies much higher than thermal noise. In recent years, single molecule imaging and nano-technologies have rapidly been expanding to include a wide range of life science applications. The dynamic properties of

biomolecules and the unique operations of molecular machines, which were previously hidden in averaged ensemble measurements, are now being unveiled. The aim of our research is to approach the engineering principle of adaptive biological systems by uncovering the unique operation of biological molecular machines. Here, I review our single molecule experiments designed to investigate molecular motors, enzyme reactions, protein dynamics and cell signaling, and discuss how thermal fluctuations (noise) play a positive role in the unique operation of biological molecular machines allowing for flexible and adaptive biological systems including muscle and brain.

About the Speaker: **Toshio Yanagida** received the B.Eng. Sci. degree in 1969, the M.Eng. Sci. degree in 1971, and the D.E. degree in 1976, all from Osaka University, Osaka, Japan. He is currently a Professor at the Department of Physiology and Biosignaling, Osaka University Graduate School of Medicine and Laboratories for Nanobiology Graduate School of Frontier Biosciences. He was the project leader of the Yanagida Biomotron Project, ERATO, JST in 1993-1997 and the project leader of the Single Molecule Process Project, ERATO, JST in 1998-2002. He was the research director of the recently completed Formation of Soft Nano Machines and is currently the research supervisor of Novel Measuring and Analytical Technology Contributions to the Elucidation and Application of Life Phenomena, CREST, JST and Vice-director of WPI Immunology Frontier Research Center, Osaka University. His research interests include the role of fluctuation in the function of bio-systems from molecular machines to the human brain. Dr. Yanagida is a member of the Biophysical Society of Japan and the American Biophysical Society. He received the 25th Naito Memorial Science Promotion Award (Naito Memorial Promotion Foundation) in 1994, a Japan Academy Award, the Imperial Award in 1998, and an Asahi Award (Asahi Newspaper Culture Foundation) in 1999.