BIOIMAGING BY X-RAY LASER DIFFRACTION AT SACLA. Yoshitaka Bessho[1,2], [1]RIKEN SPring-8 Center, 1-1-1 Kouto, Sayo, Hyogo 679-5148 Japan, bessho@spring8.or.jp, [2]Academia Sinica, Institute of Physics, 128 Academia Rd. Sec. 2, Taipei 115 Taiwan, bessho@phys.sinica.edu.tw

In order to perform the biochemical analyses of the last universal common ancestor **LUCA** and the older proto life system, we have to elucidate the system pathways of extremophile microorganisms, as in ***Thermus thermophilus***, which have deep phylogenetic branches. The maturation system of the tRNA molecule should be clarified on a structural basis, since it is the key molecule of the central dogma. Recent progress in structural biology, biochemistry, and molecular biology has encouraged us to elucidate the origin and evolution of fundamental molecular systems essential for the living cell.

Astrobiology can connect the origin and evolution of early life, and verify whether they are principles common to the universe from the characteristics of a substance. This is the voyage to search for our life spirit. The research will be shifted from "investigation of an individual life system", to “verification of the self-organization process of the life system”. Finding the answer to the fundamental question of where we, and all of life, came from is essential for understanding and elucidating the life process.

The accumulation of large quantities of protein structure information has enabled comparative examinations, toward the construction principles of a life system. In this research, the construction principle of the basic system of **the central dogma of life** will be clarified by structure-based analyses of nucleic acids, with synthetic biology knowledge, as the key elements for the genetic and protein composition systems, and their related enzymes, as in DNA replication and repair, and tRNA maturation and ribosomal translation. Some limited elements should be able to repeat diversification and integration spontaneously, and the life system must have thus materialized. This research should be able to verify the process by which a life system is formed.

The X-ray free electron laser (**XFEL**) facility, **SACLA**, at the RIKEN **SPring-8** campus, is soon expected to be useful for bioimaging with accuracy on the order of ten femto-seconds. The bioimaging of solution structures, using the SPring-8 and XFEL beamlines, should provide extraordinary information for the structural and system biology of proto life. Especially, our pulsed coherent X-ray solution scattering (PCXSS) method aims to achieve the high-resolution imaging of biological samples under close-to-natural cellular conditions. It does not require a lens for image formation, but instead numerically reconstructs object images from the coherent diffraction data.

We have successfully obtained genuine coherent X-ray speckle patterns from living bacterial cells, as well as from purified gigantic bio-molecules, such as ribosomes, by the PCXSS method. High-quality coherent X-ray diffraction (CXD) patterns were recorded from intact ***Microbacterium lacticum*** cells. An image reconstructed from the experimental CXD pattern revealed the natural nanoscale structures of live cells, thus providing clues toward understanding nucleoid structures, which are inaccessible by other methods. The technologies of this research will potentially create breakthroughs in whole cell biology, and contribute toward single-particle imaging in the future with XFEL.

We will discuss our recent results in this presentation.