Biology

Cell Proliferation Control by Organelle Derived Parasite Signal

Professor
Graduate school of Horticulture, Bioresource Science Course
Kan Tanaka

Background of Research

The first eukaryotic cell came into existence on the earth more than a billion years ago, and the only archaeocyte that was generated from the cell presumably came to be diversified into all other eukaryotic cells of animals, plants, bacteria, and so on. Very little, however, is known about the very first eukaryotic cell, as to what kind of living organism it was. We have been promoting our studies on the basis that it is indispensable to focus on the initial evolution, especially the symbiosis by the procaryotic cell in order to understand the fundamental and common system to the eukaryotic cell. In the eukaryotic cell in the initial period after its emergence, mitochondria or chloroplast that derived from the symbiosis must have been close to ancestral bacteria, and the control system by the nucleus would have been a simple one. From such a standpoint, we focused on schyzon, a species of monocellular alga inhabiting hot springs of sulfuric acid character, which is considered to be the most primitive of the eukaryotic cells currently in existence. The schyzon cell contains only a nucleus, a mitochondria, and a chloroplast. In cell proliferation, these components are first divided into two, or daughter cells for cell division. Preparation of research infrastructure and analysis of schyzon as a model eukaryotic cell are currently under way.

Achievements of Research

In the cellular symbiosis, the cell cycles that have been controlled separately need to be integrated. Having said that, the question is how the organelle genome derived from symbiosis is replicated and maintained in its relation with the nuclear genome. In a plant cell containing schyzon, the start of cell proliferation is induced by light, then replication of the organelle genome takes place first, and replication of the nuclear genome follows. As a result of advancing analysis on the mutual interaction, we discovered that what light induces is the replication of the organelle genome, and when the organelle genome is replicated, particular chlorophyll synthetic intermediates are accumulated in the cell which serve as an intracellular signal for activating G1-S CDK (cyclin-dependent kinase), which in turn induces the replication of the nuclear genome. This indicates that in the process of evolution of the plant cell, the symbiosis chloroplast synchronized the replication of the nuclear genome (or controlled the cell proliferation) by imposing a strict light checkpoint. From the stance that symbiosis and parasitism are continuous, we named this newly discovered signal as parasite signal considering it as a key to establishing symbiosis.

Prospect of Research

If the standpoint of cellular symbiosis is proved important for the proliferation control of the eukaryotic cell, it will provide a new viewpoint for a variety of related fields including medicine. The urgent task now is a comprehensive understanding of the phenomenon such as reevaluation of the mitochondria signal.