【Grant-in-Aid for Transformative Research Areas（B）】

Section III

Title of Project： Co-creation of plant adaptive traits via assembly of plant-microbe holobiont

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【Purpose of the Research Project】

As sessile organisms, plants have evolved a remarkable ability to adapt to the fluctuating environments. Molecular mechanisms by which plants respond and adapt to the surrounding environment have been extensively elucidated. However, these studies have largely overlooked a wide diversity of microbes both inside and outside plant tissues as potential contributors for plant environmental adaptation. In our research project, we consider plant environmental adaptation as a consequence of the interactions between plant and its resident microbes, which collectively form a plant-microbe holobiont (Figure). We aim to create a new research field that elucidates the molecular mechanisms underlying the assembly of the plant-microbe holobiont and its functional relevance to plant adaptation to various stress environments.

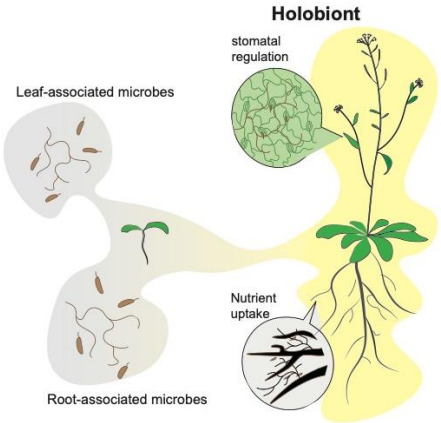

Figure The Plant-Microbe Holobiont

【Content of the Research Project】

In this research area, we will clarify the molecular mechanisms by which plant-microbe interactions in roots and leaves contribute to the environmental responses and growth of the plant as a whole. The Hiruma group will elucidate the molecular basis of plant growth promotion mediated by root-associated symbiotic fungal and bacterial communities under phosphorus- or nitrogen-limiting environments. The Mine group will uncover new aspects of plant environmental adaptation from a viewpoint of co-operative regulation of stomatal aperture by plants and leaf resident bacteria.

To accelerate these efforts, the Miyashima group will develop an imaging platform named “holobiont imager”. The holobiont imager will allow us to visualize temporal and spatial dynamics of the three key processes during the assembly of the plant-microbe holobiont: plant and microbial behaviors during interactions, mineral transport between the above and below ground tissues, and the overall plant growth. By making use of the microbial resources provided by the Hiruma and Mine groups, the Miyashima group will uncover the spatio-temporal dynamics of plant and microbial responses during the assembly of the plant-microbe holobiont.

Such a close collaboration between the three groups will enable us to elucidate the mechanisms by which interactions between plants and microbes in roots and leaves lead to the holobiont assembly and awakens the plant environmental adaptability.

【Expected Research Achievements and Scientific Significance】

Soil pollution by agricultural load and global climate change are emerging threats to agricultural productivity and food security. Understanding the plant environmental adaptation mechanisms awakened via the assembly of the plant-microbe holobiont will provide a basis for developing microbe-based agricultural technology to cope with these issues. Use of naturally occurring microbes as an agricultural technology is expected to be readily accepted by users, as it does not involve the processes of genetic manipulation of both plants and microbes.

The concept of holobiont can be applied to various research subjects beyond plant-microbe interactions, including the gut microbiota of mammals and insects, and coral reefs. The scale of holobiont is also broad, ranging from cells to tissues, individuals, populations, ecosystems, and even the earth. Under the keyword “holobiont”, we aim to gather researchers beyond the boundaries of research subjects and develop into a large research consortium that aims to elucidate commonality and diversity of the principles governing the biological functions of various holobionts.

【Key Words】

Holobiont: A holobiont is a community of a host and other organisms in or around the host, which act as if a single organism.

【Term of Project】 FY2021-2023

【Budget Allocation】 105,000 Thousand Yen

【Homepage Address and Other Contact Information】

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