

Research area in Strategic Objective “*Design of plant-derived molecules building up the foundation for plant synthetic biology*”

Function and regulation of plant molecules

Research supervisor: NISHITANI Kazuhiko (Professor, Faculty of Science, Kanagawa University)

Overview

This research area aims to achieve a comprehensive understanding of plants, focusing on plant molecules (plant-derived compounds and related genes), and to develop innovative technologies utilizing them. For these purposes, research will involve investigating the function and regulation of plant molecules at both the molecular interaction and ecological levels, and developing key technologies for exploration, identification, design and control of plant molecules. In addition to the conventional methods used in molecular biology, cell biology, ecology and plant pathology, etc., multidisciplinary approaches are encouraged to employ various research tools such as recently advanced analytical technologies and comparative genomics empowered by bioinformatics, synthetic biology and organic chemistry. Diverse plants such as agricultural crops, medicinal plants as well as model plants will be used to create new concepts and key technologies to utilize plant molecules.

Research Supervisor’s Policy on Call for Application, Selection, and Management of the Research Area

1. Background

Plants are indispensable to human life, as sources of food, pharmaceuticals and raw materials for industrial products. Considering that each of the approximately 300,000 plant species produces a vast variety of compounds, only a small portion has been used and a large number of potentially useful compounds remain to be uncovered. Accordingly, in this research area, we will focus on molecules produced by plants and also molecules acting on plants, and elucidate their function and regulatory mechanisms in plants, aiming to create a scientific basis for their utilization. One of the most important points in the promotion of this research area is to understand the biological significance that led to the

acquisition of a wide variety of compounds and their biosynthetic systems during the evolution through environmental changes and interactions with various organisms including predators, pathogens and even symbionts. We expect to create new concepts and key technologies to utilize plant molecules through ambitious and highly innovative research. To achieve this goal, multidisciplinary research is encouraged. For this reason, we also welcome researchers specializing in the fields of organic chemistry, analytical science, data science or information science who are trying to pioneer a unique approach to elucidate the function and regulation of plant molecules.

2. Specific Research Examples

(1) Function and regulation of plant molecules in individual plants

The aim is to elucidate the function and regulation of plant molecules at the molecular, cellular and individual plant levels.

- Biosynthesis and regulation of plant molecules
- Plant growth regulation mediated by plant molecules
- Mechanism of transport and accumulation of plant molecules in vivo and the morphogenic functions involved
- Function and regulation of plant molecules involved in plant parasitism, symbiosis, defense response, etc.
- Function and regulation of plant molecules related to plant nutrition
- Genome plasticity and evolutionary mechanisms generating the diversity of plant molecules

(2) Function and regulation of plant molecules in ecosystems

The aim is to elucidate the functions and significance of plant molecules focusing on biotic and abiotic environmental factors around plants from a macro perspective.

Research targets will include plant-insect interactions, plant-microbe interactions (including micro-animals), plant-plant interactions, etc. Research in controlled environments with natural ecosystems in mind will be also included.

- Interactions among organisms via plant molecules
- Plant metabolic alterations manipulated by insects and microorganisms
- Novel plant molecules active against pests and predators such as attractant and repellent
- Molecular mechanisms of host specificity
- Relationship between physical environmental factors and biological interactions
- Interactions between organisms mediated by plant molecules in air and soil (forest floor, farmland, etc.)

(3) Development of key technologies for exploration, identification, design and regulation of plant molecules

The aim is to develop new technologies that contribute to the utilization of plant molecules. Development of methods contributing to examples (1) and (2) above will also be included.

- Identification of new plant molecules and function development by integrating biology, comparative genomics and data science
- Modification of metabolic system and enzyme function based on informatics, biochemistry and structural biology
- Development of artificial evolution methods leading to the creation of new metabolic systems
- Development of novel expression methods enabling the production of rare plant molecules in heterogeneous plants or organisms including graft
- Identification and design of new plant molecules using organic synthetic chemistry techniques
- Development of basic technologies for elucidating the functions of plant molecules by chemical biology
- Development of basic technologies to improve functions of existing plant molecules
- Development of dynamic tracking and visualization technologies for plant molecules

The above are just examples, and we will also welcome proposals with high originality and relating to more than one category.

3. Selection Policy

This research area welcomes ambitious research that proposes new concepts or achieves breakthroughs in science through collaboration of plant science with organic chemistry, information science and measurement science, and also by linking micro and macro points of view. In addition to highly specialized and evidence-based research proposals, we encourage proposals with potential to expand their expected results to other materials and/or other research fields. The development of new technologies is important to stimulate breakthroughs, but this can be difficult to achieve through individual research alone. Therefore, we also welcome proposals requiring collaboration with researchers within and outside this research area. However, in this case, it is necessary to clarify exactly what part of the research will be performed by the applicant.

In FY2022 application call, we place special expectations in receiving proposals that challenge to elucidate molecular processes from the viewpoints of ecology and evolutionary biology regarding "(2) Function and regulation of plant molecules in

ecosystems." We are also expecting to receive proposals that lead to more collaboration and development between plant science and dry research fields such as informatics and computational chemistry regarding "(3) Development of key technologies for exploration, identification, design and regulation of plant molecules."

4. Research periods and funds

Research periods: 3.5 years or shorter.

Total budget: 40 million yen or less.