# 岡山大学
# OKAYAMA UNIVERSITY

## INSTITUTE OF PLANT SCIENCE AND RESOURCES

OKAYAMA UNIVERSITY

GLOBAL GATE FOR LEARNING


GUIDE BOOK 2025

# By understanding plants, we sow the seeds of tomorrow

Our institute traces its origins to the “Ohara Institute for Agricultural Research,” a foundation established in 1914 by Mr. Magosaburo Ohara. Over the past century, the institute has undergone several reorganizations and has now evolved into a research center specializing in plant science. Throughout its 110-year history, the institute has produced many distinguished scholars who laid the foundation for agricultural science in Japan.

The original mission of the institute was to “study profound scientific principles and apply them to the improvement of agricultural practices.” While this fundamental direction remains unchanged, the challenges we face today are vastly different from those of a century ago. Global climate change now threatens crop production through rising temperatures, droughts, floods, and heavy metal contamination. As a research institute dedicated to plant science, we must address these pressing issues to combat food insecurity amid a growing global population.

In 2010, our institute was designated by MEXT as a “Center for Plant Genetic Resources and Stress Science Research.” Since then, we have actively collaborated with universities and research institutions across Japan. Furthermore, Okayama University was selected for the “Program for Promoting the Enhancement of Research Universities as Regional and Distinctive Core Institutions (J-peaks),” in which our institute plays a key role in plant science.

Our institute also plays a vital role in graduate education. Over the years, we have welcomed talented students from across Japan and around the world to Kurashiki, nurturing many outstanding researchers.

We are committed to advancing the Institute of Plant Science and Resources as a premier hub for research and education.

**Director**
**Jian Feng Ma**

IPSR
SINCE 1914

## Institute of Plant Science and Resources (IPSR)

The institute quickly acquired a status of a widely open and welcoming collaboration center for domestic and foreign researchers. Its current scientific mission aims development of new generation crops that will be suited for multitude of stress environments, and promote agricultural production in stress-affected areas worldwide.

## Research Core for Future Crops

The objectives of this core are to exploit new research topics that are expected to be important in the near future and to advance future-oriented studies in plant stress science.

・Crop Design Research Team

## Research Core for Plant Stress Science

In each unit, plant stress responses and plant interactions with other organisms are studied using various approaches of physiology, biochemistry, stress tolerance mechanisms, and genetics.

### Atmospheric Stress Unit
- Plant Light Acclimation Research Group
- Group of Environmental Response Systems
- Group of Functional Biomolecular Discovery

### Soil Stress Unit
- Group of Plant Stress Physiology
- Group of Plant Molecular Physiology
- Plant resilience research group

### Biotic Stress Unit
- Group of Plant-Microbe Interactions
- Group of Plant-Insect Interactions
- Plant Immune Design Group
- Group of Plant Environmental Microbiology

## Barley and Wild Plant Resource Center

The center promotes collaborative research using the internationally significant genetic resources and techniques in plant science.

### Genetic resources unit
- Group of Genome Diversity

### Applied genomics unit
- Group of Genetic Resources and Functions
- Group of Integrated Genomic Breeding

## RECTOR program

The International Research Center Formation Program to Accelerate Okayama University Reform has been established in 2019.

# Milestones in IPSR History

## Always in Kurashiki: History of IPSR

IPSR, the successor to the “Ohara Institute for Agricultural Research”, was established in 1914 by Magosaburo Ohara, the renowned Kurashiki philanthropist. Since its establishment, the institute has remained located in the center of Kurashiki City. After affiliated with Okayama University in 1952, IPSR was reorganized and renamed several times.

## IPSR is recognized as a Joint Usage/Research Center of "Plant Genetic Resources/Stress Science Research" by the Ministry of Education, Culture, Sports, Science and Technology

Since 2010, we have annually accepted about 50 collaboration projects, and many publications have been released through joint research. We organize an annual symposium on plant science and resources, together with workshops for specific research topics. We share information with the research community via organization of the Plant Stress Science Research Network (PSSNet).

## 1.5-ha experimental field

In natural harmony, genetic resources of plants are used to embrace individual groups’ efforts at improvement of plant resilience, sustainable society development, and genomic breeding of future crops. Along with the greenhouse facilities, a 1.5-ha experimental field is attached to the research buildings that host large and diverse arrays of high-tech research equipment.

## IPSR offers abundant genetic resources, cultivation facilities, and analytical equipment for Collaborative Research

Advanced research equipment and instruments are well-maintained by our technical support department and made available for the “Joint Usage/Research Center” research projects. Aside from its research facilities, Kurashiki Campus also accommodates an annex library of the Okayama University and its unique collection of rare books, some of which are from the institute’s founding era (Pfeffer’s collection on plant physiology, and others).

IPSR Branch Library

# Research Core for Plant Stress Science

Atmospheric Stress Unit | Soil Stress Unit | Biotic Stress Unit

Atmospheric Stress Unit

## Plant Light Acclimation Research Group

Professor Wataru Sakamoto
Associate Professor Ryo Matsushima
Associate Professor Yuki Okegawa

https://www.rib.okayama-u.ac.jp/english/research/pla-hp/

### Photosynthesis and chloroplast biogenesis: Understanding to innovation

Our life on earth cannot continue without the atmospheric environment, which is maintained by oxygenic photosynthesis. Plants perform photosynthesis in chloroplasts, where light energy is converted into chemical energy by a series of electrochemical reactions. In contrast, sessile land plants are exposed incessantly to excess light energy or harsh atmospheric environments that engender 'photodamage'. How do plants cope with such photosynthetic inactivation? What are the key elements to maintaining or even maximizing chloroplast functions? Our group studies various aspects of chloroplast development and photosynthesis. Through understanding of the factors involved in photoprotection and chloroplast function, we aim at improving crop productivity against atmospheric stress over the long term.

Atmospheric Stress Unit

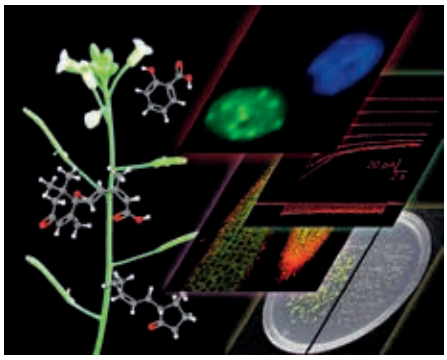
## Group of Environmental Response Systems

Professor Takashi Hirayama
Associate Professor Izumi Mori
Associate Professor Yoko Ikeda

https://www.rib.okayama-u.ac.jp/english/research/ers-hp/

### Uncovering secrets of plants: how plants 'know' their surroundings and 'think up' ways to cope with them

Being sessile, plants must adapt to all environmental changes or perish. Plants are already well-known to recognize environmental fluctuations and to respond promptly to such changes. Nevertheless, it remains unclear how plants dissect and integrate environmental signals and make a decision to render an optimal response even with no information-integration systems such as those of our central nervous system. To address this question, our group investigates environmental stress response systems of plants using physiological, molecular biological, and molecular genetic approaches. Among plant stress responses, we emphasize the studies of stress-associated plant hormone signaling and stress-associated chromatin regulation. Our ultimate goal is to take advantage of the research outcomes to create stress-tolerant crops.



Atmospheric Stress Unit

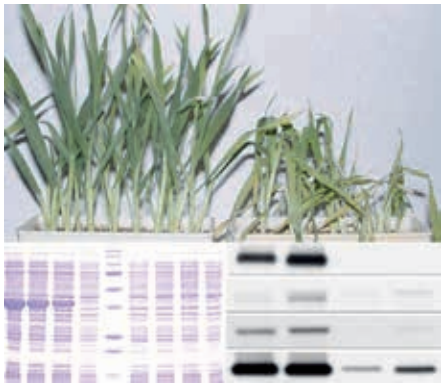
## Group of Functional Biomolecular Discovery

Associate Professor Manabu Sugimoto
Assistant Professor Kazuhide Rikiishi

https://www.rib.okayama-u.ac.jp/english/research/pgm-hp/

### Application of functional biomolecules for developing plants supporting future society

Plants are sensitive to various environmental stimuli. They respond to physical, chemical, and biological stress factors. Consequently, plants can undergo changes in their development, morphology, and physiology during their life cycle. We have used biochemical and molecular biological techniques to elucidate the functions of enzymes, proteins, and gene regulating factors, which are all related to stress tolerance mechanisms of plant cells under environmental stress conditions. Through our research, we aim at developing plants that can adapt well to adverse and extreme environments to resolve difficulties such as food shortages and environmental degradation.



Soil Stress Unit

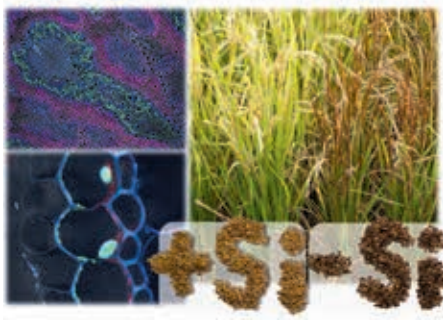
## Group of Plant Stress Physiology

Professor Jian Feng Ma
Associate Professor Naoki Yamaji
Associate Professor Namiki Mitani-Ueno
Assistant Professor Noriyuki Konishi

https://www.rib.okayama-u.ac.jp/english/research/ps-hp/

### Strategies of plants to overcome mineral stresses

Plants rooting in soil must take up mineral nutrients as well as water for their growth. A deficiency or excess of a mineral element can cause growth inhibition. However, some plant species have developed strategies to overcome mineral stresses. Our group specifically examines the mechanisms of uptake, distribution, and accumulation of mineral elements including essential, beneficial and toxic elements from the intact plant level to the gene level. We aim at making a future contribution to sustainable and safe crop production.



Soil Stress Unit

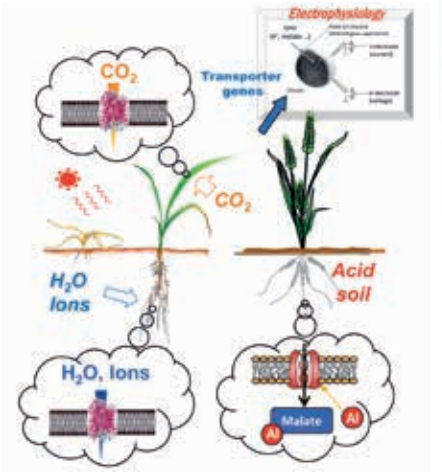
## Group of Plant Molecular Physiology

| | |
|---|---|
| Professor | Maki Katsuhara |
| Associate Professor | Takayuki Sasaki |
| Assistant Professor | Shigeko Utsugi |

https://www.rib.okayama-u.ac.jp/english/research/mp-hp/

### Water and ion transport mechanisms in response to environmental stresses

Our group has been particularly addressing response and adaptation mechanisms to environmental stresses in plants by molecular analyses and cellular levels. Specifically, we are investigating the diverse physiological functions of aquaporins (ability to transport water, hydrogen peroxide, and ions in some molecular species), functions of aquaporins in seed formation, the physiological roles of cation transporters in salt stress response, inhibitory effects of aluminum on plant growth in acidic soils, the physiological functions of *ALMT* as an aluminum-tolerance gene, and the diversity of gene families.




Soil Stress Unit

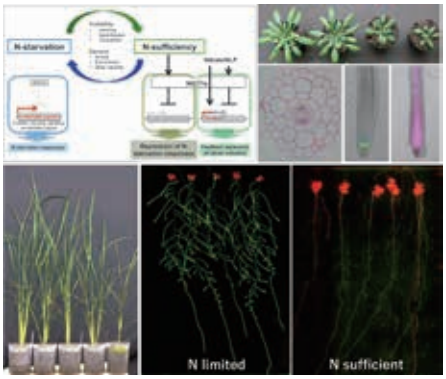
## Plant resilience research group

| | |
|---|---|
| Professor | Takatoshi Kiba |

https://www.rib.okayama-u.ac.jp/english/research/prr/

### Exploring mechanisms underlying plants' resilience to nutrient deficiency

Plants have evolved "environmental resilience": the capability of responding flexibly and robustly to environmental fluctuations such as changes in temperature, light, water availability, and nutrient levels. Our group aims to elucidate the molecular mechanisms which underlie plant resilience to nitrogen availability fluctuations. Nitrogen is necessary for plant growth and agricultural productivity, but excessive fertilizer use has led to severe environmental difficulties. With knowledge of these mechanisms, we intend to contribute to the development of sustainable agriculture.




Biotic Stress Unit

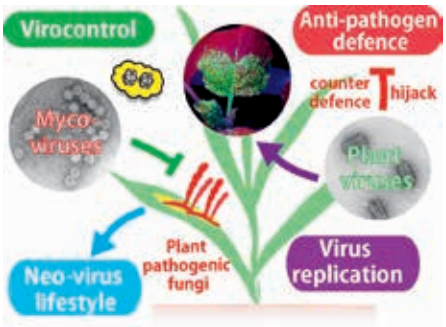
## Group of Plant-Microbe Interactions

| | |
|---|---|
| Professor | Nobuhiro Suzuki |
| Associate Professor | Hideki Kondo |
| Associate Professor | Kiwamu Hyodo |

https://www.rib.okayama-u.ac.jp/english/research/pmi-hp/

### Ascertaining the interplay between plants and beneficial and harmful viruses

Plant growth is influenced by interactions between plants and various microorganisms. Viruses, bacteria and fungi pathogenic are threats to plants. By contrast, some viruses infect phytopathogenic fungi and reduce their virulence, thereby having potential as biocontrol agents. This group studies various bipartite (plant - virus) or tripartite (plant - pathogenic fungus - mycovirus) interplays with specific examination of the multifaceted nature of microbes. Our ultimate goal is to contribute to the promotion of healthy growth of crops and other plants.




Biotic Stress Unit

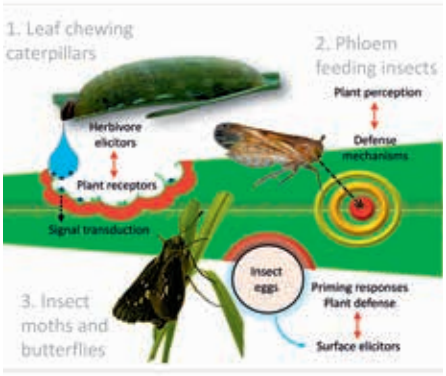
## Group of Plant-Insect Interactions

| | |
|---|---|
| Professor | Ivan Galis |
| Associate Professor | Tomonori Shinya |

https://www.rib.okayama-u.ac.jp/english/research/2013pii/

### Elucidation of plant-insect interactions at the molecular level

Establishment of effective plant defense systems against herbivores in natural history reflects the existence of extremely variable interactions between plants and insects, also known as co-evolution process. Our group strives to understand, at a molecular level, the mechanisms of activation, signal transduction and metabolic basics of plant defenses triggered after the recognition of insect attack. Furthermore, we target sustainable pest control by the use of natural enemies and their attraction to herbivore-infested plants by the emissions of various volatile organic compounds (VOCs) from plants.



Biotic Stress Unit

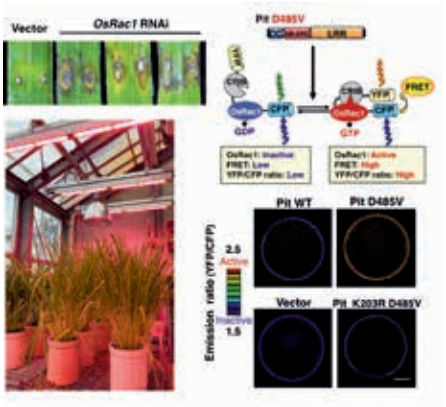
## Plant Immune Design Group

Professor Yoji Kawano
Assistant Professor Fumi Fukada

https://www.rib.okayama-u.ac.jp/english/research/pid-hp/

### Plant immune design through comprehensive understanding of rice immunity

With the global population projected to reach 9 billion by 2050, an urgent need exists for innovation in sustainable crop production. Our research focuses on rice, a major staple crop, with the aim of engineering traits that enhance disease resistance. Utilizing advanced techniques such as genome editing and live-cell imaging, we explore key components of plant immunity, including immune receptors and the small GTPase OsRac1. We also clarify the mode of action of hormone-like peptides that modulate plant immunity. Moreover, we investigate the infection strategies of rice blast fungus. By integrating insights from both plant immunity and pathogen invasion, we aim to contribute to the development of more resilient rice cultivars.




Biotic Stress Unit

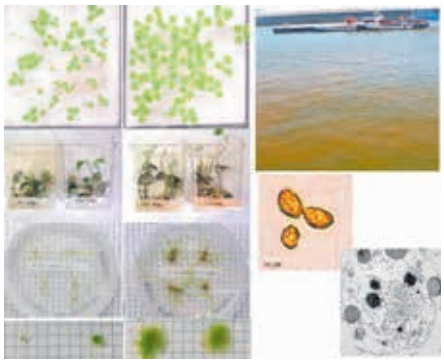
## Group of Plant Environmental Microbiology

Associate Professor Akio Tani
Associate Professor Shoko Ueki

https://www.rib.okayama-u.ac.jp/english/research/pem-hp/

### Deciphering molecular mechanisms of symbioses among plants, algae, bacteria, and viruses

*Methylobacterium* species that predominate in the phyllosphere utilizing methanol emitted from plants can promote plant growth. Their methanol metabolism includes an enzyme dependent on lanthanides, which have been regarded as non-essential metals for any kind of life; we ascertain its importance in microorganisms both genetically and biochemically.
On the other hand, we characterize biotic interactions between a bloom forming algae and marine bacteria or viruses, which shape algal population dynamics in environments. We are trying to decipher these interspecies interactions at the molecular and cellular levels.



# Barley and Wild Plant Resource Center

Genetic Resources Unit | Applied Genomics Unit

Genetic Resources Unit

## Group of Genome Diversity

Professor Hiroshi Hisano
Associate Professor Daisuke Saisho
Assistant Professor Koichi Yamamori

https://www.rib.okayama-u.ac.jp/english/research/gd-hp/

### Analysis of the diversity of barley genetic resources and trait improvement

Our group specifically conducts investigations into the analysis and application of barley diversity using approximately 20,000 accessions, including landraces, cultivars/breeding lines, experimental lines and wild relatives collected worldwide. The main subjects of our research are (1) Diversity analysis of genetic resources and their genomes, (2) Genome sequencing and generation of genome-related resources, and (3) Genetic analysis of industrial useful traits and development of genetic engineering methods. Our activities, which include the collection, preservation, and distribution of barley genetic resources, are partially supported by the National BioResource Project (NBRP), MEXT, Japan, contribute to the research community worldwide.


Applied Genomics Unit

## Group of Genetic Resources and Functions

Professor Shin Taketa
Assistant Professor Jun Yamashita

https://www.rib.okayama-u.ac.jp/english/research/gr-hp/

### Molecular genetics of barley: seed quality and spike morphology

Barley, the fourth most important cereal crop in the world, typically has seeds with adhered hulls. This hulled seed trait is suitable for breweries. Some naked seed mutants with easily separable hulls were generated through a spontaneous mutation. They are suitable for food usage. Results of our research demonstrate that barley awns and spike hulls are photosynthetically active. Our current research specifically examines molecular identification and characterization of beneficial genes controlling (1) seed morphology and quality, including water soluble healthy dietary fiber, and (2) photosynthetic contribution of awns and hulls using mutants. We seek application of our basic findings to practical breeding.

Applied Genomics Unit

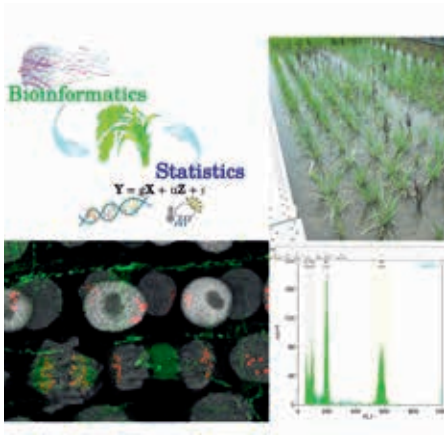
## Group of Integrated Genomic Breeding

Professor Toshio Yamamoto
Associate Professor Kiyotaka Nagaki
Associate Professor Tomoyuki Furuta

https://www.rib.okayama-u.ac.jp/english/research/ng-hp/

### Understand the genome and chromosome dynamics for future crop breeding

Along with rapid changes in global environments in recent years, agricultural environments are also changing rapidly. To continue food production under these changing circumstances, we must develop varieties that can adapt to those changes more rapidly than ever. Our research group has been investigating the genomic constitution of vast rice genetic resources, which are the driving force of breeding, specifically examining rice productivity and environmental stress tolerance, and developing identification methods for genes (group) capable of responding to various breeding targets. We have also been investigating chromosome dynamics in cross breeding.




# Research Core for Future Crops

## Crop Design Research Team

Specially Appointed Associate Professor June-Sik Kim

### Digitizing crop environmental responses: From genes to development

By leveraging genetic resources at IPSR and integrating diverse data on plant physiological responses to environmental fluctuation, our team accelerates the discovery of genes contributing to enhanced crop productivity. Understanding gene-environment interactions in field conditions is crucial for agricultural advancement.

Through comprehensive analytical techniques, we elucidate physiological state transitions throughout crop life cycles under real-world conditions. Additionally, we develop computational methodologies that utilize to predict agronomic traits. This integrated approach—combining genetic resources, environmental monitoring, and predictive analytics—enables us to bridge the gap between laboratory findings and practical agricultural applications, ultimately advancing our understanding of how crops adapt and perform in dynamic field environments.

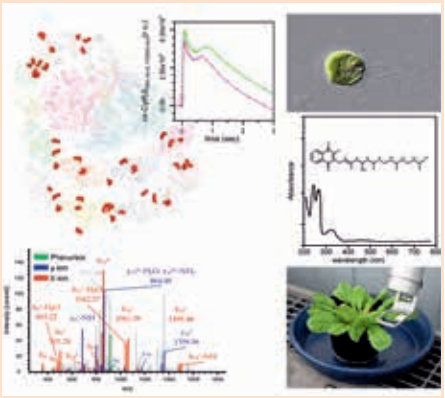
## RECTOR program

Specially Appointed Professor Michael Hippler
Associate Professor Shin-Ichiro Ozawa

https://www.rib.okayama-u.ac.jp/RECTOR/

### Illustrating molecular machinery of plant bioenergetic toward optimization of photoenergy on agricultural crops

We established the International Research Center Formation Program to Accelerate Okayama University Reform (RECTOR Program) in 2019, which operates under the direct control of the president and serves as a leading measure for University reform aimed at developing stronger research capabilities, inviting the overseas principal investigator. Our group is driven by the aim to understand plasticity of bioenergetic principles that enables energy transformation and $CO_2$ fixation permitting acclimation and adaptation in response to the environment. These acclimation strategies are dynamically and transiently linked with redox- and/or secondary mediated regulatory processes as well as to post-translational modifications. To measure dynamic transitions, we are employing fast optical spectroscopy, mass spectrometry, and structural biology approaches.



## Joint Usage/ Research Center Program

We accept collaborations in wide areas of plant biology, biochemistry and molecular biology, and support them with state-of-art equipment and research facilities in the institute.

https://www.rib.okayama-u.ac.jp/english/collaboration/collaboration-index/

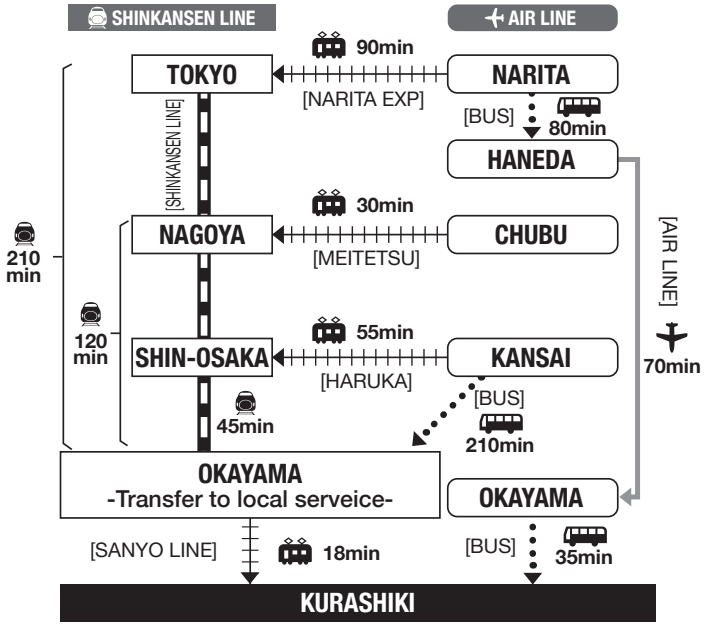
## Kurashiki Guest House

Kurashiki Guesthouse was built to support collaborators who stay on campus, conducting research and scientific discussions, while enjoying the comfort of spacious rooms near Kurashiki historical town.

https://www.rib.okayama-u.ac.jp/english/collaboration/guesthouse/

# Access & Routes

## Domestic Transportations to Kurashiki





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