岡山大学

OKAYAMA UNIVERSITY

Institute of Plant Science and Resources

OKAYAMA
UNIVERSITY

Global gate for learning

GUIDE BOOK 2023

By understanding plants, we sow the seeds of tomorrow

Institute of Plant Science and Resources (IPSR), one of the research institutes and centers affiliated with National Universities in Japan, emphasizes studies of education and research in plant science in its contributions to the Graduate School of Environmental and Life Science. Through our research, IPSR promotes the use of plant genetic resources and develops basic knowledge to enhance understanding of plant stress responses. Since 2010, we have acted as a nationwide Joint Use/ Joint Research Center to provide support to the broad research community in our designated fields, genetic resources, and plant stress responses. In practical terms, we offer tangible resources to researchers, improve research environments such as experimental field and research buildings, extending our support to nearly 600 collaboration projects to date, and contributing to the development of plant science within and beyond Japan.

During this century, negative effects on the global environment brought about by human activities have become exceedingly apparent. Sustainable Development Goals (SDGs) were proposed with recognition of the necessity of resolving these issues urgently, as a difficulty faced by all humankind, to build a foundation for sustainable society. It is no wonder that plant science should play a major role in the process. Accordingly, at IPSR, we aim at accelerating the basic research of plant stress responses through efficient utilization of available genetic resources. We believe that our mission for the accomplishment of SDGs has become crucially important.

Director
Takashi Hirayama

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
- Field Flora Research Team
- Crop Functional Innovation Research Team
- Crop × Environment 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

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
- Group of Wild Plant Science

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
Assistant 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

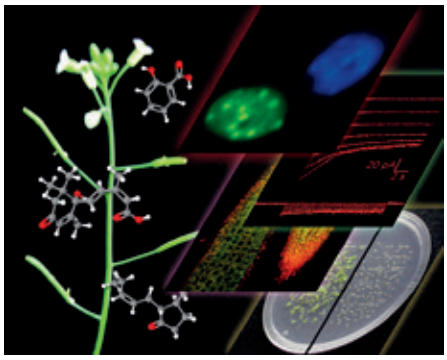
Group of Environmental Response Systems

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

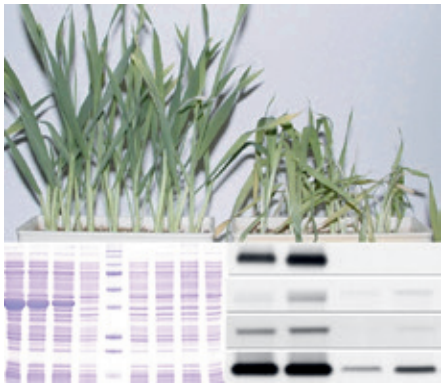
Group of Functional Biomolecular Discovery

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

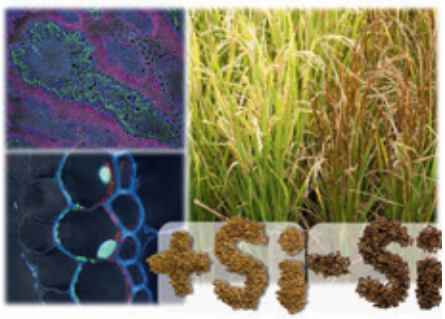
Group of Plant Stress Physiology

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

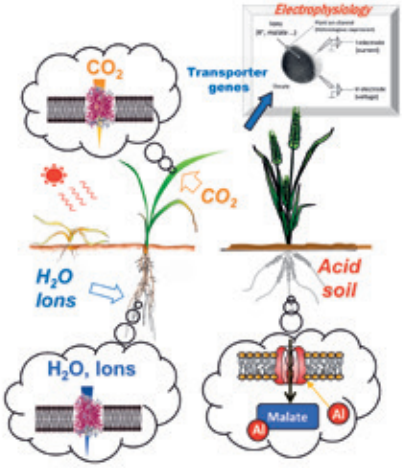
Group of Plant Molecular Physiology

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.



Biotic Stress Unit

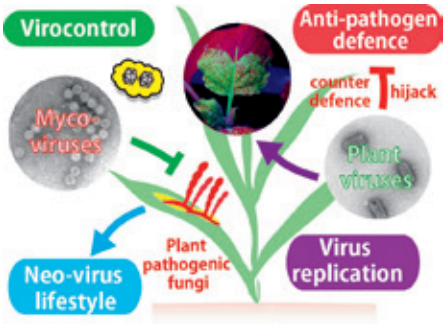
Group of Plant-Microbe Interactions

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

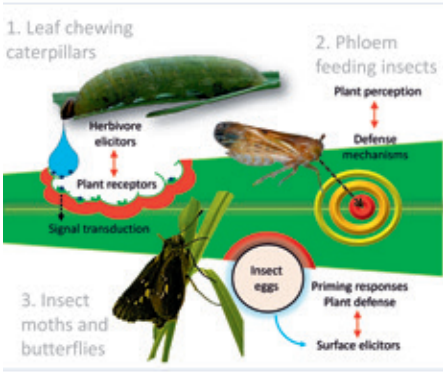
Group of Plant-Insect Interactions

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

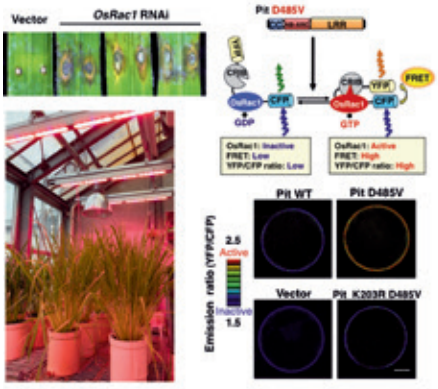
Plant Immune Design Group

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

The global population is estimated to reach 9 billion by 2050. Agriculture will have to change fundamentally to support such a great number of people. Improving rice, the most important crop, is a key research goal. Our ultimate goal is to design rice traits to confer biotic stress tolerance. Our research focuses on immune receptors and the small GTPase OsRac1, which are key factors supporting rice immunity. We believe that a comprehensive understanding of immune receptors and OsRac1 functions will enable us to design rice immunity. To accomplish this goal, we combine cutting-edge technologies such as live imaging and genome editing.



Biotic Stress Unit

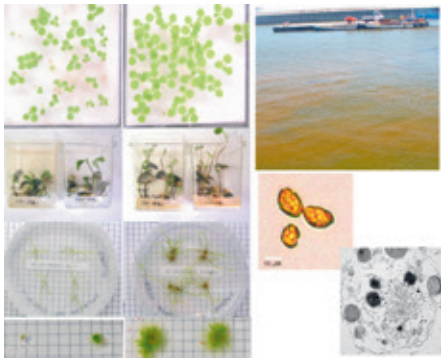
Group of Plant Environmental Microbiology

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 Kazuhiro Sato
Associate Professor Daisuke Saisho
Associate Professor Hiroshi Hisano

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

Analysis and application of genome diversity in barley genetic resources

Our group specifically conducts investigation into the analysis and application of barley diversity using ca. 20,000 accessions including landraces, cultivars/breeding lines, experimental lines and wild relatives collected worldwide. 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 traits with industrial importance and their technical applications. Our activities for collection, preservation, and distribution of barley genetic and genomic resources, which are partially supported by the National BioResource Project, MEXT, Japan, contribute to the research community worldwide.

Genetic Resources Unit

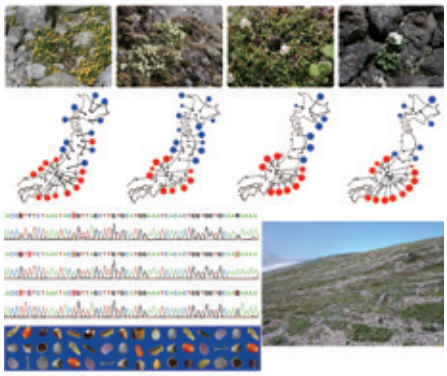
Group of Wild Plant Science

Associate Professor Hajime Ikeda
Assistant Professor Jun Yamashita

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

Natural variation and evolution of plants

Earth is home to over 300,000 known species of plants. This diversity of plant species has been shaped mainly through adaptive evolution to various environments, including abiotic as well as biotic ones. By particularly addressing evolutionary genomics of wild plants, we attempt to reveal relationship between plant evolution and natural environment and to elucidate mechanisms that shaped plant diversity. In addition to such basic research, we preserve and distribute wild plant seed resources.



Applied Genomics Unit

Group of Genetic Resources and Functions

Professor Shin Taketa

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

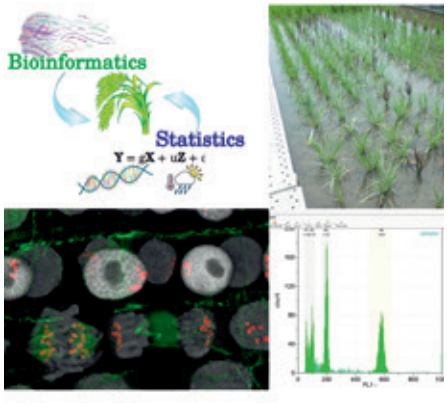
Group of Integrated Genomic Breeding

Professor Toshio Yamamoto
Associate Professor Kiyotaka Nagaki
Assistant 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 adopting genetic resources at IPSR and integrating a broad range of data and knowledge related to the physiological responses of the plant to environmental fluctuation, our group aims to accelerate the discovery of genes which contribute to higher crop productivity. Understanding the interactions of genes and environmental changes in plants under field conditions is crucially important. Our group, by integration of various comprehensive analytical techniques, has been promoting research to elucidate the physiological state transitions of crops throughout their life course in field conditions. Furthermore, we have promoted the use of field data for development of analytical methodologies to predict agronomic traits of crops computationally.

Field Flora Research Team

Associate Professor Akio Tani (adjunctive)
Associate Professor Naoki Yamaji (adjunctive)
Associate Professor Daisuke Saisho (adjunctive)
Associate Professor Hideki Kondo (adjunctive)
Professor Toshio Yamamoto (adjunctive)

Relationship between the plant growth and environmental factors in double cropping

This team is a cross-disciplinary team established in 2017. In the institute fields, double cropping of rice and barley is repeated every year, with and without fertilizer. Plant (crop) growth and yield is affected not only by their genotype and the resultant phenotype, but also by environmental factors. By utilizing multi-omics approach, we are monitoring growth of crops, transitions of ions available in the rhizosphere, and rhizosphere microflora throughout the year, and explore the ecological relationships that exist among them.

Crop Functional Innovation Research Team

Associate Professor Hiroshi Hisano (adjunctive)
Associate Professor Hideki Kondo (adjunctive)
Associate Professor Ryo Matsushima (adjunctive)
Associate Professor Namiki Mitani-Ueno (adjunctive)

Development of a research hub for crop functional innovation using barley

Our research team specifically examines improvement of genetic modification technologies of barley, a major crop worldwide. This technology is important for overcoming food and environmental difficulties that human beings are facing today. For example, such technologies can support the improvement of various agricultural characteristics related to crop production, such as biotic and abiotic stress tolerance, in a shorter time than ordinary breeding systems. Currently, we are investigating the improvement of barley seed components and elucidating cryptic viruses that might be present in field-grown barley. By advancing these studies, we intend to establish a research center for crop functional innovation.

Crop × Environment Design Research Team

Associate Professor Daisuke Saisho (adjunctive)
Associate Professor Yoko Ikeda (adjunctive)
Associate Professor Akio Tani (adjunctive)
Associate Professor Naoki Yamaji (adjunctive)
Assistant Professor Tomoyuki Furuta (adjunctive)
Specially Appointed Associate Professor June-Sik Kim

Understanding crop genetic resource × environment interactions for future breeding

For sustainable agricultural production, it is necessary to understand the seasonal transition of the field environment, adaptive crop genotypes, and their interactions, and to connect them to crop breeding practices. Using barley germplasm, we have been collecting multi-year, multi-environment agronomic trait data, as well as soil minerals and rhizosphere microbiota in double-cropping fields of rice and barley. This team, which started in 2022, will deepen our understanding of the genetic structure of crop × environment interactions, and develop verification research using resources such as multi-parent populations and mathematical models predicting the impact on agronomic traits.

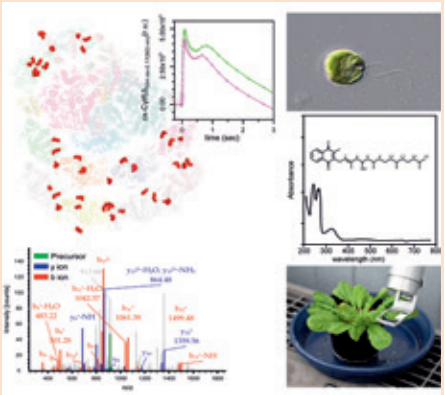
RECTOR program

Specially Appointed Professor Michael Hippler
Assistant 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/

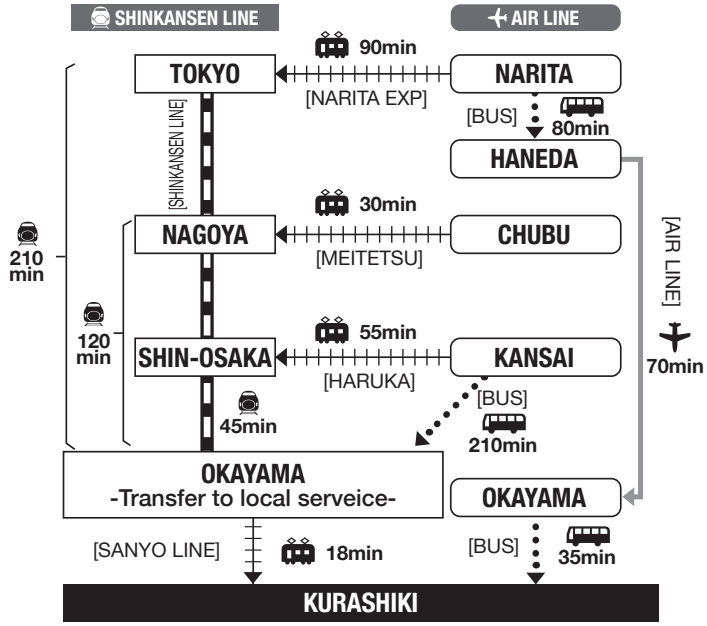
Kurashiki Guest House

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



2023.4

OKAYAMA UNIVERSITY
University Mark

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