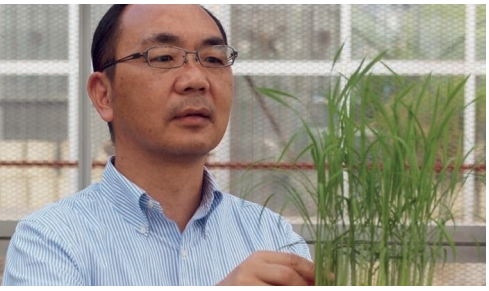

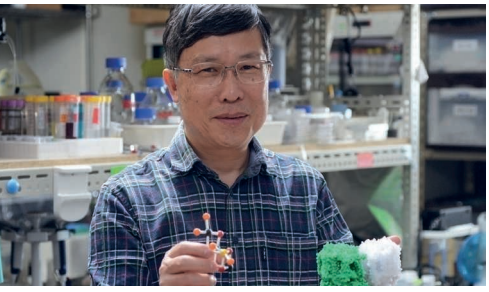

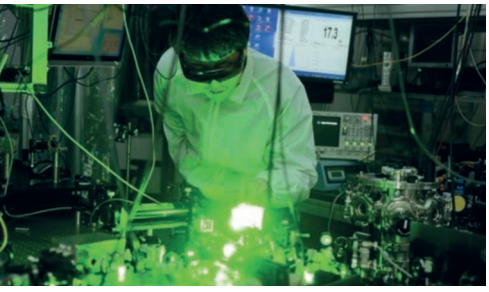

## Okayama University

# Leading the way, from plants to planets

**Okayama University has built a well-earned reputation as one of the world's leading hubs for research in fields as diverse as plant science and planetary science, and it has recently opened a centre dedicated to the emerging field of interdisciplinary research.**

It is hard to conceive of two fields so different as plant science and planetary science, but researchers at Okayama University in Japan are conducting leading research in both fields at the Institute of Plant Science and Resources (IPSR) and the Institute for Planetary Materials (IPM). With the establishment of the Research Institute for Interdisciplinary Science (RIIS) in 2016, Okayama University is aligning its research strengths to lead the way in new and emerging fields.

### Investigating the science of plants

One of the oldest biological research institutes in Japan, the IPSR has a proud history of research in agricultural sciences aiming to help farmers through realizing advances in agronomy and to address the country's most pressing food-supply issues.

"The IPSR has made several significant contributions to plant and agricultural sciences over its more than 100 year history," says institute director, Masahiko Maekawa. "Researchers from our institute were the first to link cadmium contamination of food with a condition known as itai-itai disease in Japan. In follow-up work, we have recently clarified the molecular mechanisms behind cadmium uptake in rice, which has led to the development of a rice strain that is resistant to cadmium accumulation. This is one example of practical research being undertaken at the IPSR."

Alongside rice, barley features strongly in the IPSR's research programme as a crop of regional and global significance. The institute boasts one of the largest barley germplasm collections in the world, and, as part of the International Barley Core Collection, is recognized as a leading barley genebank.

"Our researchers were major contributors to the International Barley Genome Sequencing Consortium, which concluded in 2012, and they recently identified a seed dormancy gene that controls preharvest sprouting," says Maekawa. "This research into barley genomics also strengthens our research of other crops."

Some of the most exciting areas of research being undertaken at the IPSR include mineral stress in crops, microorganisms and their interactions with plants, crop breeding and photosynthesis.

"Research into plant stress responses is urgently needed at a global scale," says Maekawa. "In addition to our own research on plant science, we have established international collaborative research projects and development programmes with Jomo Kenyatta University of Agriculture and Technology in Kenya and the Boyce Thompson Institute for Plant Research at Cornell University in the USA, among others. These programmes aim to encourage information exchange and researcher visits to find novel solutions for improving plants and crops in the context of population growth and climate change."

Jian Feng Ma, a biology professor at the IPSR, is leading research aimed at finding and understanding new transporters involved in the uptake and transport of minerals such as silicon, cadmium, arsenic, aluminum and manganese. "We aim to reveal their function, structure and

regulating mechanism," says Ma. "This will lead to a better understanding of the entire system of element transport in crops, particularly in rice and buckwheat, which will help us understand the uptake of both essential and toxic elements from the soil to different plant tissues. Understanding the plant mineral transport system is thus very important for both crop production and food safety."

At the IPSR, researchers enjoy access to facilities, such as sequencers for plant genetics, specialized facilities for studying plant responses and adaptation to variable stress conditions, and a vast library of plant genetic resources, including a comprehensive collection of wild plant seeds. There are also well-maintained greenhouses and fields for rice, barley, wheat and sorghum research.

"Besides conducting research, one of our most important missions is to develop the next generation of researchers," says Maekawa. "Our institute admits both domestic and international students, and our educational programmes aim to foster internationally active researchers with training courses in English. They are exposed to advanced analytical methods and state-of-the-art equipment for plant biology research."

## Exploring Earth and other worlds

The IPM is another of Okayama University's world-class research centres. Reorganized under the new name in 2016 with a new mission to investigate the origin, evolution and dynamics of the Earth and planets, the IPM builds on more than three decades of Earth science research.

"The IPM and its predecessors have played a leading role in the fields of analytical planetary chemistry and experimental geophysics," says institute director, Eizo Nakamura. "Our new mission strengthens our research into the origin of life and mineral–organic–water interactions in planetary materials."

Hosting a comprehensive suite of state-of-the-art geochemical analysis systems, which is unmatched anywhere in the world, the IPM is uniquely equipped to conduct comprehensive, in-depth studies of planetary materials using both analytical and experimental approaches. The research facilities include a comprehensive analytical system capable of detecting most elements and isotopes, a suite of advanced material dating techniques, and a range of high-pressure and high-temperature experimental systems, which are complemented by advanced spectroscopic and diffraction facilities and computational systems.

"The research environment at the IPM is unparalleled, both in Japan and globally," says Nakamura. "Our facilities are some of our most important research assets. Part of our mission is to make these advanced experimental and analytical facilities as well as our expertise available to researchers in Japan and worldwide as a national and international research and educational hub in Earth and planetary materials science."

The evolution of asteroids in the Solar System is one of the most important and exciting research areas that IPM is exploring. Nakamura's research group, for example, is deeply involved in asteroid sample return missions conducted by Japan Aerospace Exploration Agency (JAXA) and NASA.

"We work with JAXA as curators for the Hayabusa2 Phase-2 mission, including initial analysis of samples obtained from the asteroid Ryugu. We will also be involved in analyzing samples from NASA's OSIRIS-REx and Mars 2020 missions."

The IPM is investigating how asteroids form and move around the Solar System — a recent study of the Chelyabinsk meteorite based on comprehensive textural and geochemical analyses conducted at the institute showed that this 'ordinary' chondrite meteorite was captured by a cometary ice body and transported from the main asteroid belt to a near-Earth orbit.

"Thanks to the efforts of its staff and the support of the Japanese government and Okayama University, this institute has become an ideal environment for the experimental study of terrestrial and planetary materials," says Nakamura. "We invite researchers and students from all over the world to join us to foster the next generation of leaders in the global Earth and planetary science community."

## Bridging gaps between disciplines

Bringing together researchers in fields as diverse as structural biology, superconductors, energy storage, carbon-based electronics and neutrino physics, the RIIS aims to bridge the gaps between traditional disciplines where the most promising research opportunities are now emerging.

"The RIIS has five main research themes," says institute dean, Yoshihiro Kubozono. "We have a team working on the structural biology of the photosystem II protein complex, another conducting theoretical chemical research on energy-storage materials, one working on high-performance transistors of polycyclic hydrocarbons and graphene as the basis for carbon-based electronics, a particle physics team with strengths in neutrino research, and a superconductor team, which is studying the design and physics of new, high-temperature superconductors."

The research at the RIIS builds on Okayama University's existing strengths and research talent. For example, the photosystem II research extends an original breakthrough by its researchers in the structural characterization of this essential biological system, while the superconductor research comes out of a world-class team, which includes researchers who helped discover new high-temperature superconductor systems.

"Our teams are made up of world-class researchers in their respective fields, and we explore interdisciplinary research through their collaboration," says Kubozono. "We are also now pursuing collaborations with international researchers to strengthen our institute as a world-class research hub."

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