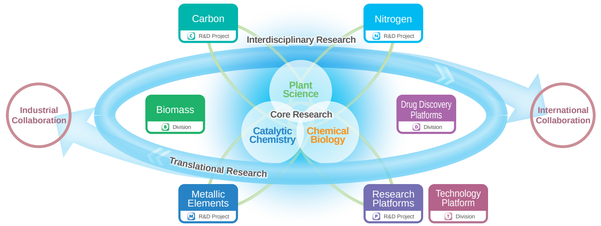


Fundamentals of the center; **Core Research**

RIKEN created a center collecting three of its strong fields, "Plant Science", "Chemical Biology", and "Catalytic Chemistry", to elucidate the diversity of biological functions and chemical diversity. While chemistry examines molecular structures, their reactions and phenomena at the molecular level, biology considers the overall flow of genetic information and molecular systems. By learning both sides of the coin, we endeavor to create disruptive research and technologies for the sustainable production of materials, energy and food.

Integrating the strong points of the center; **Interdisciplinary Research**

CSRS has established four unique interdisciplinary projects, "Carbon", "Nitrogen", "Metallic Elements" and "Research Platforms", across the core CSRS scientific fields. Scientists from plant science, chemical biology and catalytic chemistry interact with one another to tackle challenges in science and technology essential towards innovation for a sustainable future.

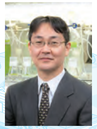
Divisions of Biomass, Drug Discovery Platforms and Technology Platform

"Biomass" and the "Drug Discovery Platforms" were established as part of the RIKEN Research Cluster for Innovation, to accelerate knowledge exchange between RIKEN and other institutions or companies. While the "Technology Platform" provides research platforms supporting the activities of CSRS.

Knowledge and Technology transfer; **Translational Research**

Outstanding core research in each specialized field and integrated knowledge obtained from interdisciplinary projects are transferred to society by collaborating with industry. More than 30 collaborative research projects have started towards realizing "open innovation" by proactively matching industry needs with research seeds from CSRS, in cooperation with the Business Development Office of RIKEN Research Cluster for Innovation and the CSRS Planning Office. Collaboration with other institutes and universities are also important means to extend center activities and encourage interaction with worldwide research communities. Beyond various individual collaborations, CSRS promotes research networks, such as consortiums and joint graduate courses with universities in Japan, as well as international collaboration. In particular, CSRS promotes inter-ministry collaboration as a way of achieving innovation.

Group Directors


Hiroshi Sakakibara


Ken Shirasu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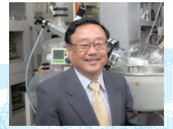
RIKEN
Center for Sustainable Resource Science

Contributing through integration of biology and chemistry, to achieving a sustainable society that recycles both resources and energy

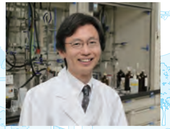

Director: Kazuo Shinozaki

The RIKEN Center for Sustainable Resource Science is working to lay the foundations for a sustainable society, based on an understanding of the diversity of both biological and chemical functions. To achieve this goal, we have adopted three key projects. The first project, focusing on carbon, aims to develop technologies to transform carbon dioxide (CO_2) into useful resources, through photosynthesis or catalytic chemistry. In the second project, which focuses on nitrogen, we are developing plants that can grow in harsh environments or with low nitrogen and phosphorus fertilizer input, as well as innovative ways to synthesize ammonia from nitrogen. Finally, in the metallic elements project we are aiming to develop new technologies that use biological functions to recover metals and clean the environment, and to develop innovative low-cost, high-efficiency catalytic technology based on the properties of various metals. In addition, we are dedicated to building a research infrastructure to make possible the production and use of the biological and chemical resources needed for the research conducted under each of the projects. CSRS's mission is to contribute to society by developing biomass engineering, chemical and energy production technologies, and sustainable agriculture that maximize efficiency and reusability of resources, which are gentle on the natural world enabling a sustainable society.

Deputy Directors


Hiroyuki Osada


Kazuki Saito


Zhaomin Hou

Towards an environmentally friendly cycle of biological and chemical resources

Plants and microbes incorporate a wide range of biological functions. Many natural compounds are biosynthesized by organisms in nature, and humans can produce other useful materials using chemical synthesis. At the RIKEN Center for Sustainable Resource Science we aim to elucidate the diversity of these biological functions and chemical diversity. Promoting energy conservation by creating new sustainable resources based on the use of biological functions and chemical resources such as carbon, nitrogen and metallic elements, without placing a load on the environment.

Sustainable Resource Science

Core Research

Plant Science

Climatic risks such as global warming, and demands of a steadily growing population threaten food security. CSRS Plant Scientists explore molecular foundations of plant physiology, to build strategies to manipulate the genome and 'metabolome', the diverse set of chemical compounds in a plant, in order to maximize their durability and productivity even in climate change.

Chemical Biology

CSRS Chemical Biologists have built a unique collection of naturally occurring biologically active molecules known as the 'Natural Products Depository'. Together with a robust and rapid screening chemical array, they serve as an important tool for small molecules. Furthermore, Chemical Biology plays an important role linking plant sciences to chemistry.

Catalytic Chemistry

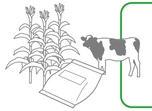
Developing new catalysts allow new, economically and ecologically sound processes and techniques to access products required by society in vital areas including food, materials and energy. CSRS Catalytic Chemists challenge to develop new catalysts to facilitate useful chemical reactions previously thought impossible.

Interdisciplinary Projects

Creation of useful materials from *carbon* and oxygen in the atmosphere

R&D Project of Carbon Utilization

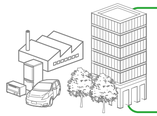
Global warming is caused by the increasing concentration of carbon dioxide (CO_2) in the atmosphere. Thus, recovering and using this CO_2 will be beneficial in terms of both the environment and resources. Plants take in CO_2 by photosynthesis to produce primary metabolites such as sugars and lipids and various secondary metabolites. We are working to develop enhanced photosynthesis by identifying regulatory factors. In addition, we are developing not only plants that can effectively fix CO_2 for the production of useful materials but also microorganisms and catalysts with added chemical diversity. Our goal is to develop technology to allow us to freely produce useful resources from CO_2. We are also developing novel catalysts that make it possible to use the oxygen in the atmosphere to engage in oxidation without putting a load on the environment.



Synthesis of ammonia from *nitrogen* in the atmosphere in an energy-saving way and production of crops with low-input

R&D Project of Nitrogen Utilization

The industrial synthesis of ammonia from nitrogen and hydrogen is carried out at high temperatures and high pressures, consuming huge amounts of fossil fuels. We aim to develop novel catalysts that enable nitrogen fixation and ammonia synthesis under mild conditions. We also aim to discover genes and biologically active substances that enable plants to grow even in poor nutrient environments and to develop crops that can produce high yields even with low nitrogen, low phosphorus fertilizers. For increased crop production, we are developing crops with high productivity, pathogen resistance and environmental stress resistance. Nitrate ions contained in fertilizers are released into the atmosphere as nitrous oxide through the process of denitrification. Nitrous oxide is a greenhouse gas that is 300 times as potent as CO_2, so we are also aiming to develop technology to reduce emissions of this gas.



Efficient recovery and use of useful *metallic elements* without imposing a load on the environment

R&D Project of Metallic Elements Utilization

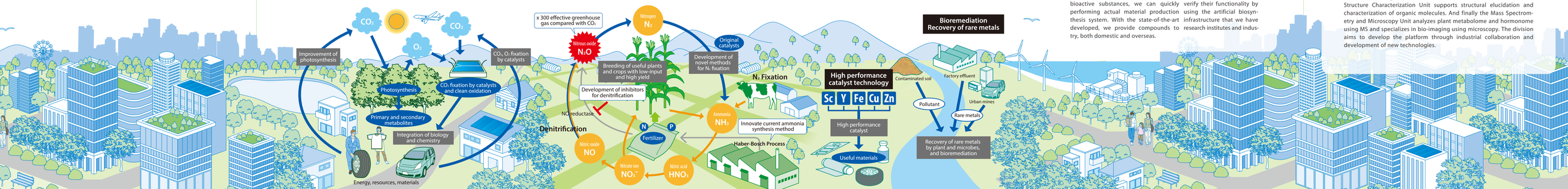
Chemical synthesis has brought us a variety of useful materials through the development of various catalysts. However, many of the metals used in catalysts are rare and expensive, and Japan depends on imports for most of them. We are working to develop novel highly active and selective catalysts, consisting of readily available and inexpensive metals. On the other hand, it is important to recover and reuse the valuable metals that lie buried in our "urban mines." We are aiming to promote technology transfers to recover useful metal resources efficiently without imposing a burden on the environment, by using plants such as moss and microorganisms. This technology will also contribute to bioremediation of metal-contaminated soil and water.

Establishment of *research platform* for the discovery and utilization of sustainable resources

R&D Project of Research Platforms

Under the research platform organically the Metabolomics we research the metabolic integrated manner; and the Chemical compounds from microorganisms. Putting an "integrated metabolomics platform." functions of metabolic products obtained to quickly become apparent, and to Chemical Bank. We evaluate the activity substances and develop a platform that with useful functions such as enhanced fixation, suppression of denitrification, addition, we aim to develop an artificial using plants and microorganisms. When bioactive substances, we can quickly performing actual material production thesis system. With the state-of-the-art developed, we provide compounds to try, both domestic and overseas.

project, we are combining Analysis Platform, in which products of organisms in an Bank, a collection of natural these together, we will build As a result, we expect the from metabolome analysis increase the diversity of the of physiologically active can search for substances photosynthesis and nitrogen and metal recovery. In biosynthesis system platform we find useful genes and verify their functionality by using the artificial biosynfrastructure that we have research institutes and indus-



Divisions

Biomass Engineering Research Division

Biomass engineering involves a new engineering concept a in developing technologies that integrate the increased production of biomass from plants and its utilization. As an alternative resource to petroleum, plant biomass is used to create fuels and chemical materials in an effort to achieve aims such as innovation in production processes. This commitment is helping to achieve a shift from a consumption society to a sustainable society: the former requires the use of fossil resources, while the latter uses recyclable plant biomass.

Drug Discovery Platforms Cooperation Division

Academic drug discovery has become a world-wide movement at universities and research institutions, in response to which the RIKEN launched the Drug Discovery and Medical Technology Platforms (DMP). Capitalizing on RIKEN's excellent track record in basic science and technology, including a vast library of bioactive natural products and state of the art equipment for high throughput screening (HTS), our division aims at making innovative contributions to the academic drug discovery effort.

Technology Platform Division

The division consists of three supporting units providing a research platform for CSRS activities. The Biomolecular Characterization Unit provides advanced structural characterization aiming to further understand the mechanism and action of biological molecules. Through operation of NMR and MS devices, the Molecular Structure Characterization Unit supports structural elucidation and characterization of organic molecules. And finally the Mass Spectrometry and Microscopy Unit analyzes plant metabolome and hormonome using MS and specializes in bio-imaging using microscopy. The division aims to develop the platform through industrial collaboration and development of new technologies.