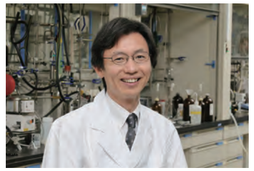
Project Leader: Kazuki Saito

R&D Project of Carbon Utilization

Biology and chemistry are like two sides of a coin. We can move towards a sustainable society by learning from one another.

Plants and microorganisms use photosynthesis to produce a range of substances. In turn, humans use these substances as food, industrial materials, energy sources, pharmaceuticals and health supplements. Chemistry, for its part, can efficiently produce various substances with the aid of catalysts. The problem we always confront is whether we can use chemistry to replicate what nature does. Conversely, can organisms replicate what chemistry does? Biology and chemistry are related in this way, and we endeavor to develop technology to recycle carbon into useful resources while striving to learn from one another.

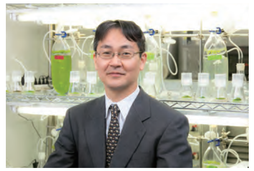


Project Leader: Zhaomin Hou

R&D Project of Nitrogen Utilization

Integrating the power of chemistry and biology to develop low-input plants and novel catalysts that can produce useful substances.

In order to enhance the synthesis of ammonia, a process that requires large amounts of energy, we are developing catalysts that can convert nitrogen and hydrogen into ammonia within moderate conditions, and chemical technologies that will allow the direct synthesis of organic substances from the abundant nitrogen in the atmosphere. We are also working to achieve low fertilizer plant production by using chemical and biological methods. While chemistry examines phenomena at the molecular level, biology considers the overall flow of information. The concepts and methods are different, but by working together in the same center on the same goals, scientists will be able to make epoch-making discoveries from unexpected places.



Project Leader: Hitoshi Sakakibara

R&D Project of Metallic Elements Utilization

We are sifting through diverse biological functions and elements, searching for those that can contribute to the environment and resources, hoping to transfer this knowledge to industry.

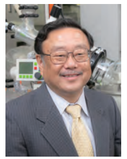
Metals are used, in a wide range of forms, in the products that surround us. However, some of them are very rare, and some are harmful to living organisms. In order to achieve a sustainable society, humanity must find substitutes for the rare elements and find ways to reduce their usage by recycling. We are discovering useful mechanisms, within a diverse range of life forms, to recover metals and clean the environment. Additionally, by developing efficient catalysts that do not use rare metals, we are contributing to the creation of a low-resource-consuming, energy-efficient society.

R&D Project of Research Platforms

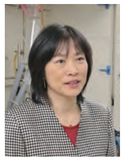
We are supporting research with a new research platform that incorporates biosynthesis and screening of chemicals.

Recently, we have discovered an important lipid that supports plant growth in phosphorus-depleted soil. We are hoping, through this, to make it possible to grow plants with little fertilizer. This type of research for the discovery and production of useful substances is becoming increasingly important. We hope to quickly accumulate knowledge on the functions and production mechanisms of metabolites, and this will be made possible by the development of an integrated metabolomics platform. By combining the metabolomics platform and our chemical bank of natural products, we are strengthening research on the discovery and biosynthesis of compounds. We are also using our state-of-the-art infrastructure to provide compounds to research institutes in Japan and abroad.

Group Director



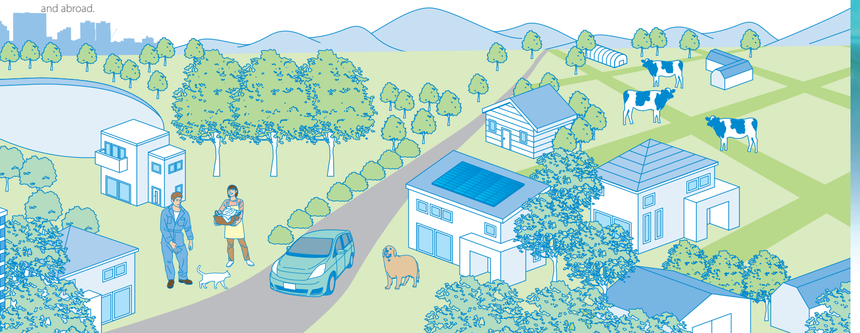
Hiroyuki Osada



Mikiko Sodeoka

Ken Shirasu

Minoru Yoshida



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RIKEN
Center for Sustainable Resource Science

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

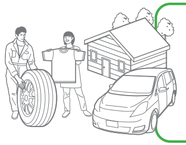
Director: Kazuo Shinozaki

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. Simultaneously we are aiming to create new energy resources and chemical materials from biomass as a substitute for fossil fuels, in collaboration with the RIKEN Research Cluster for Innovation.

Towards an environmentally friendly cycle of biological and chemical resources

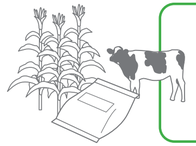
Plants and microbes incorporate a wide range of biological functions. Many natural compounds are biosynthesized by organisms in nature, and humans can produce other useful materials using chemical synthesis. At the RIKEN Center for Sustainable Resource Science we aim to elucidate the diversity of these 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



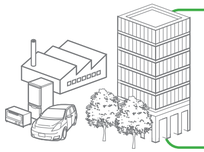
Creation of useful materials from *carbon* and oxygen in the atmosphere

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

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

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.