CSRS promotes flagship projects towards achievement of the Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development

In 2015, the United Nations General Assembly adopted a set of 17 SDGs to be achieved by 2030. The power of science and innovation is essential when addressing these global issues. Against this backdrop, CSRS will leverage its strength in research and promote flagship projects focusing on seven goals as shown below. In addition to transdisciplinary research in plant science, chemical biology, catalytic chemistry, and biomass engineering, CSRS will adopt latest technology in data science, artificial intelligence (AI), and genome analysis to produce innovative results.

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RIKEN
Center for Sustainable Resource Science

Contributing to a sustainable society through research oriented towards “problem-solving” based on the concept of developing manufacturing methods with reduced environmental impact

Since its establishment in 2013, RIKEN Center for Sustainable Resource Science (CSRS) has been a leader in creating a sustainable society through transdisciplinary integration of plant science, chemical biology, catalytic chemistry, and biomass engineering. The growing risk from climate change and energy issues, however, calls for research oriented towards “problem-solving” that contributes, more than ever before, to sustainable growth and that addresses global issues.

Using as guides the Sustainable Development Goals (SDGs) and the Paris Agreement on achieving zero greenhouse gas emissions, CSRS has set up six flagship projects. Each of these projects aims to further advance basic research in the efficient creation, exploration, and use of beneficial substances from natural resources, sustainable food production, and bioproduction that CSRS has been undertaking in the past. In addition, the projects will move beyond the boundaries of research fields and develop manufacturing methods with less impact on the environment. In particular, advances made in recent years in artificial intelligence (AI) and data science can bring about a significant step forward.

While establishing new research field of “sustainable resource science” that contributes to solving environmental problems and food-related issues, and also actively nurturing the next-generation of scientists, CSRS will lead in creating a future world where people can live healthy and prosperous lives.

Director
Kazuki SAITO

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Ken SHIRASU

Zhaomin HOU

Mikiko SODEOKA

Akihiko KONDO

From basic research to application and innovation: Six flagship projects, using information science, providing solutions to global issues

Through cross-cutting research collaboration in plant science, chemical biology, catalytic chemistry, and biomass engineering, CSRS has consistently produced world-class research.

Our next mission will be to apply this state-of-the-art research and leverage research findings in the respective fields towards achievement of the SDGs and produce tangible results contributing to creation of a sustainable society. For example, our success in the demonstration of drought-resistant rice cultivation will become the foundation for further development in "Innovative Plant Biotechnology" project. Similarly, the elucidation of the symbiotic strategy between legumes and rhizobia will be developed in the "Integrative Symbiological Solutions" project, and the synthesis of isoprene, a raw material used for synthetic rubber, from biomass, development of high-performance catalysts and highly functional polymers will be further advanced in the "Metabolic Genome Engineering" project and in the "Innovative Catalysts" and "Leading-edge Polymers" projects, respectively.

CSRS sees these flagship projects as the core foundation for research and will collaborate with research institutes, universities, and corporations in and outside Japan to address global issues.

B Innovative Plant Biotechnology

Contributing to sustainable food and biomass production through development of plant trait improvement techniques

With global warming, climate change, and population increase, sustainable food supply and procurement is now a global issue. CSRS has been using model plants to explore and elucidate the functions of beneficial genes and promoting research for translating the results in actual crops. Based on these research results, the Innovative Plant Biotechnology project aims to develop plants with high qualitative and quantitative value added with resistance to environmental stress and diseases.

In addition, the project will use omics analysis to explore peptides and other regulators and employ chemical biology approaches to elucidate main factors leading to improvement of productivity and functionality of foods and biomass. To ensure transfer of the results in the field to the actual farmland under varying conditions, the project will also use information science to store and analyze data from multiple angles for trait improvement.

While stable food procurement is becoming an issue, speedy genome decoding and analysis and advances in information science and technology have enabled accurate exploration of genetic information. As such a trend significantly increases the prospect for development of innovative technology, growing expectations are being placed on scientists.

At the moment, we are carrying out joint research on production with research institutes in Southeast Asia and other regions. While deepening collaboration with these specialist organizations in and outside of Japan, we would like to positively utilize our research results on genomic information we have accumulated and trait improvement techniques to return to society.

Project Leader
Minami MATSUI

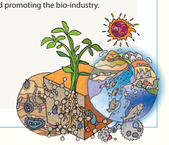
S Integrative Symbiological Solutions

Developing scientific technologies based on symbiotic interactions for solving global environmental problems

To solve environmental problems such as pollution and climate change, we will elucidate symbiotic relationships in the soil and hydrosphere. By utilizing symbiotic microbial functions, we will develop sustainable and environmentally friendly agricultural and environmental technologies that do not rely heavily on chemical fertilizers and pesticides.

We will also develop technologies to monitor symbiotic dynamics in order to quickly recognize and predict environmental changes. In addition, we aim to identify symbiotic microorganisms that have the ability to produce unknown useful substances, and to elucidate their biosynthetic mechanisms and create useful compounds using genome mining, omics, biochemistry, structural biology, and computational chemistry approaches.

Following the adoption of the SDGs and the Paris Agreement, there is an urgent need to promote sustainable economic growth and solutions to social issues such as climate change and stable food supply. Nitrogen and phosphorus are important as fertilizers in agriculture, but when they are released into the atmosphere and soil, they could cause global warming and pollution. In this project, we will implement nitrogen fixation technology and phosphorus utilization technology using symbiotic microorganisms, prediction and purification of the hydrosphere using symbiotic microorganisms, and creation of useful compounds by symbiotic microorganisms. Through these efforts, we will advance our understanding of symbiotic phenomena and contribute to solving global environmental and food problems and promoting the bio-industry.



Project Leader
Ken SHIRASU

M Metabolic Genome Engineering

Maximizing capacities of plants and microorganisms for chemical synthesis in expanding the production and use of bioproducts

Departure from our dependence on fossil resources requires creation of bioproducts essential to our lives through innovative methods. Using genomic analysis data that are increasing exponentially as well as synthetic biology, genome engineering, and data science, the Metabolic Genome Engineering project will artificially maximize capacities of plants and microorganisms for chemical synthesis in developing and configuring sustainable production systems.

The project will promote the synthesis of useful substances from plants and microorganisms by taking on the challenge of developing smart organisms through designing metabolic pathways from the interactions of multiple cells, creating advanced forms of breeding of plants and microorganisms that make up the production systems, and synthesizing compounds that had been difficult to develop using existing chemical synthesis. There are many potential targets, including raw materials for the chemical industry, functional foods, drugs, and raw materials for cosmetics. Development of the technology base and partnership with the industry is expected to bring about further advances in this field.

The humankind has exploited fossil resources produced by plants in the ancient times to provide greater convenience in our lives. Fossil resources, however, are expected to be depleted in a few decades, and it will be up to us to create the resources necessary for human survival. The ultimate goal will be to depart from our dependence on fossil resources by designing entire life forms. Beyond microorganisms and plants, we envision eventually expanding our scope of research into aquatic organisms and the natural environment. While returning some of the benefits to the plant kingdom, we hope to engage in this far-reaching research and produce results.

Project Leader
Akihiko KONDO

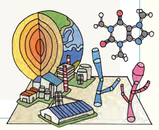
C Innovative Catalysts

Developing new, highly efficient catalysts that use natural resources

Transformation of our lifestyle to one without dependence on fossil fuel is an important theme for bringing about a sustainable society. Even though natural resources are finite, new beneficial resources can be produced from natural resources through the actions of highly functional catalysts. The Innovative Catalysts project will develop advanced catalysts that enable efficient use of the atmosphere, water, and earth crust resources of the global environment to contribute to stable supply and recycling of environmental resources.

Some of the focal points will be development of new catalyst technology for synthesizing ammonia from nitrogen and hydrogen under mild conditions and development of catalysts for synthesis of carboxylic acids using carbon dioxide, which is considered as the major cause of global warming, as raw material. In addition, the project will develop metal-based catalysts for manufacture of hydrogen and other substances through water splitting, biofunctional catalysts that function in water, and catalysts that are based on cheap, earth-abundant elements and that take the advantage of the features of all available metals for chemical synthesis. Through such innovation, the project will change the notion that "Japan is a country poor in resources."

Catalysis is a key technology for skillfully using limited resources to create substances useful to humankind. Development of innovative catalysts can not only lead to environmentally friendly manufacturing methods that save resources and energy, but also result in the creation of new substances with innovative functionality. As research projects that meet the needs of the times can quickly lead to commercialization, joint research with private companies is expanding. The work in this field is really challenging and rewarding.



Project Leader
Zhaomin HOU

P Leading-edge Polymers

Developing new polymers with beneficial functions improving efficiency in the use of resources and creating new industries

Achieving the Sustainable Development Goal (SDG) of "Responsible Consumption and Production" also means that we make efforts towards achieving a sustainable society that strikes a balance between the environment and economy. Through groundbreaking synthesis techniques using molecular catalysis, the Leading-edge Polymers project will develop, from plants, biomass, and fossil resources, biopolymers having new functionalities, and lead efforts towards their commercialization.

Polyethylene and other polyolefins make up about 70% of all polymers used in our world today. To further broaden its potential, the project will develop functional polyolefin materials that have excellent adhesive properties with other materials, develop acrylic resins used in organic glass, create super engineering polymers with high-strength and high-temperature heat resistance properties, and develop the technology for creating high-toughness peptide polymer materials that combine strength and flexibility. These efforts will, through collaboration with the industry, promote efficiency in the use of resources as well as bring innovation in the chemical industry.

Polymeric materials that abound in our life and products such as plastic bottles were created from accumulation of research into materials. Development of a polymer database has been difficult, but collecting information on the structures and performance of pure materials and building up foundational technology will lead to pioneering the next-generation manufacturing. If we can establish such a foundation, it will be possible to predict outcomes and create molecular designs that more closely meet expectations. To deliver expected outcomes, CSRS will work closely with scientists of plants, metabolism and fermentation, and speedily use the research results in a sweeping process leading up to collaboration with companies.

Project Leader
Hideki ABE

TP Advanced Research and Technology Platforms

Advancing analytical technology and information platforms and leading innovation as a science and technology hub in Japan

RIKEN, with its state-of-the-art platform for molecular analysis, is actively conducting joint research with other research institutes and universities, with the Technology Platform Division at the core. The Advanced Research and Technology Platforms project will use and further refine RIKEN's analytical and information platforms and support the efficient promotion of the flagship projects.

Specifically, such efforts will include development of analytical technology for automatic identification of compounds; sophistication of the integrated metabolome analytical platform, including plant hormones that help us understand all intracellular metabolism, the imaging technology platform using electron microscopy, and the phenotype analytical platform; establishment of the platform for development of bioactive substances that combines research covering an extensive field from plants to microorganisms; and further expansion of the chemical bank. To support these analytical technologies, the project will also use and refine the cross-cutting information platform. The project will lead RIKEN's efforts in forming a science and technology hub and bring about the next-generation innovation while deepening collaboration with the industry.

The project aspires to have CSRS's platforms contribute to promoting science and technology in Japan as well as around the world. For that purpose, the project will nurture young scientists in the boundary between chemistry and biology, and will serve as a hub in bringing scientists together around the chemical biology platform.

Project Leader
Naoshi DOHMAE

It is truly rewarding to be taking on the challenge of using the information platform to further refine the analytical technology platform, both in terms of hardware and software. We will further promote research to enable automation of metabolome analysis and three-dimensional imaging.

Project Leader
Masami HIRAI

Gathering CSRS's research findings to vigorously promote cross-cutting collaboration within RIKEN and collaboration with other research institutes and industries in Japan and abroad

D Drug Discovery Platforms Cooperation Division

Academic drug discovery has become a world-wide movement at universities and research institutions. RIKEN facilitates academic drug discovery by conducting the Drug Discovery and Medical Technology Platforms (DMP). To achieve this goal, it is necessary to develop novel assay systems based on recent advances in genome and iPS cell research. Capitalizing on RIKEN's vast library of bioactive natural products, optimized assay systems, and state of the art equipment for high throughput screening (HTS), our division aims at making innovative contributions to the academic drug discovery effort.