RIKEN

Stimulating Serendipity

ANNUAL REPORT

2013–2014

Stimulating serendipity

RIKEN has a mission to fulfill toward society, and we fulfill it well. But I do not believe that we can ever afford to sit on our laurels. It is the dramatic advances we achieve—the things that were not declared in our mission statement—that make us a truly exceptional and necessary part of society.

Major scientific breakthroughs often come through serendipity, in many cases by thinking outside the box. We cannot order such achievements, but we can create an environment that increases the likelihood of advances. In 2013 we set up a new research structure that encourages interaction within RIKEN, with the aim of creating synergies between scientists in different disciplines.

As another part of our reforms, we have put systems in place to stimulate interactions between researchers at RIKEN and key actors in other sectors of society. We hope that by promoting the circulation of ideas we can encourage young researchers to travel out of their own boxes, interact, and bring back new ideas that can lead us to great innovations.

That is also why we extend a warm invitation to international scientists to join our research community.

Networking is the key to success in science and the key to creating a better future.

NOYORI Ryoji (DEng)
President, RIKEN

Introduction

RKEN supports excellent research that contributes to the technological and economic development of Japanese society and the quality of life of the Japanese people. We are globally connected. New ideas can span the world in seconds. New devices can be designed, created and delivered to any continent in weeks, and most of the challenges we face are global in nature. In 2013 science and technology itself is global, the opportunities to contribute to society are global, and the challenges we face are increasingly shared.

RIKEN scientists are making their contribution to challenges in many fields. Our synchrotron, supercomputer, and other research infrastructure are helping thousands of scientists in Japan and around the world to tackle bigger, bolder questions. The triumphs of medical research are bringing extended life span—a boon but also a challenge as we struggle with the disease burden of an aging population. RIKEN's contributions in 2013 included:

- a focus on personalized medicine—developing revolutionary therapies by working across disciplines; looking on the body as an interactive system; and developing individual therapies with early results including insights into diabetes therapy, spine disorders and Alzheimer's disease
- the first clinical trial of induced pluripotent stem cells—for treating the world's most common cause of blindness
- the conclusion of an eight-year experiment with 25 generations of cloned mice, and discoveries in how long-term memories are stored in the brain and how false memories arise.

The achievements of industrialization have brought higher standards of living to East and West but at a price: a warming world and the need for more sustainable energy and production options. RIKEN's inventions in 2013 included:

- technologies to improve lithium batteries
- sustainable ways of making almost limitless amounts of silk, collagen and other proteins using *E. coli*
- an iron catalyst for hydrogenation
- new materials for thermoelectric power generation, low energy electronics and other applications.

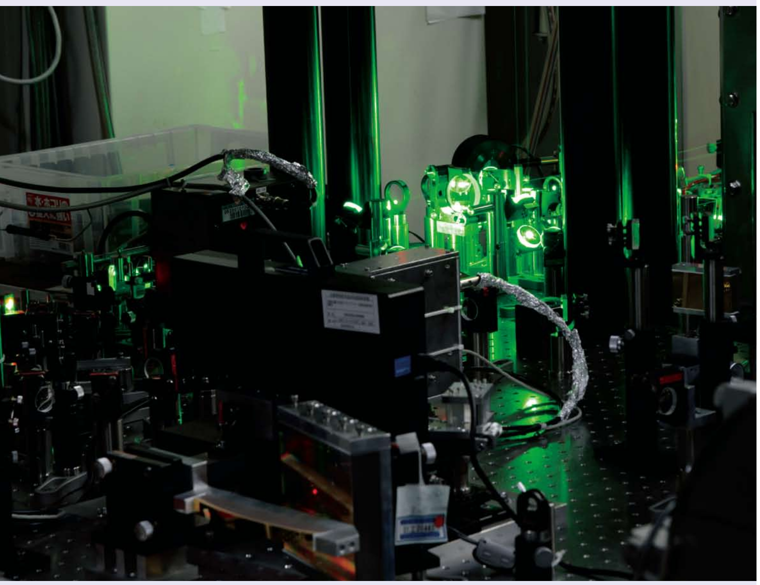
The Green Revolution has made food plentiful and cheap, but how will we feed another two to three billion people by 2050? Some of RIKEN's contributions in 2013 were:

- a new simple synthesis method for trifluoro-methylated amine compounds, a component of many agrochemicals
- a low-energy process to make ammonia for fertilizers.

RIKEN scientists are also undertaking fundamental research—opening new fields of scientific endeavor. Highlights in 2013 included:

- ways to measure protons and antiprotons
- observing matter falling into black holes
- elucidating how the stable "magic numbers" of protons and neutrons in atomic nuclei change for certain isotopes.

This report outlines RIKEN's achievements and developments in 2013 as we started a new five-year plan. You can find out more about the many projects mentioned on our website (www.riken.jp/en) and through our publications, including *RIKEN Research*.



Written by Tim Thwaites, Margie Beilharz and Niall Byrne, Science in Public. For further information on the research presented in this publication or to arrange an interview with a researcher, please contact:

RIKEN
Global Relations and Research Coordination Office

2-1 Hirosawa, Wako, Saitama 351-0198, Japan
TEL: +81-48-462-1225
pr@riken.jp

For RIKEN's latest research reports, see:
www.riken.jp/en/research/rikenresearch

Table of contents

Interview with Executive Director Maki Kawai

Mobilizing synergies: RIKEN's Third Five-Year Term

In 2013, RIKEN embarked upon its third five-year term. What were the major changes?

Kawai: Today, we expect science to make advances in the fundamental academic disciplines as well as contributing solutions to the problems faced by society. For this reason, we adopted the concept of "mobilizing synergies" as the pillar of our third five-year term.

This meant two major changes to our organization in April 2013.

First, we consolidated a number of research groupings in the life sciences to bring together researchers from diverse areas to carry out interdisciplinary and collaborative research in integrative medicine, life science technologies and sustainable resources.

Second, we created two new centers in the new fields of emergent matter and photonics. Other functions that had also previously been undertaken at the Advanced Science Institute are being spread throughout RIKEN as a whole, so that we can continue to form new strategic research centers.

One year has passed since the transformation. Do you feel any change in how research is done?

Kawai: The key idea behind the reorganization was to promote joint work between researchers in different disciplines, and I feel that this is being achieved.

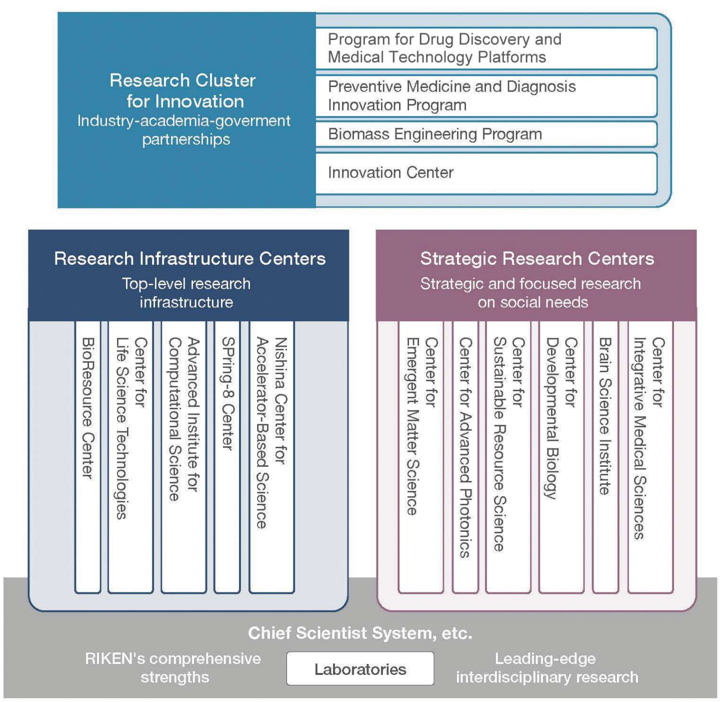
We are also encouraging interdisciplinary collaboration through grants for projects in pioneering areas beyond the fields being carried out in the current centers. This funding mechanism, called the Competitive Program for Creative Science and Technology, requires applicants to put together a multidisciplinary team from inside or outside RIKEN.

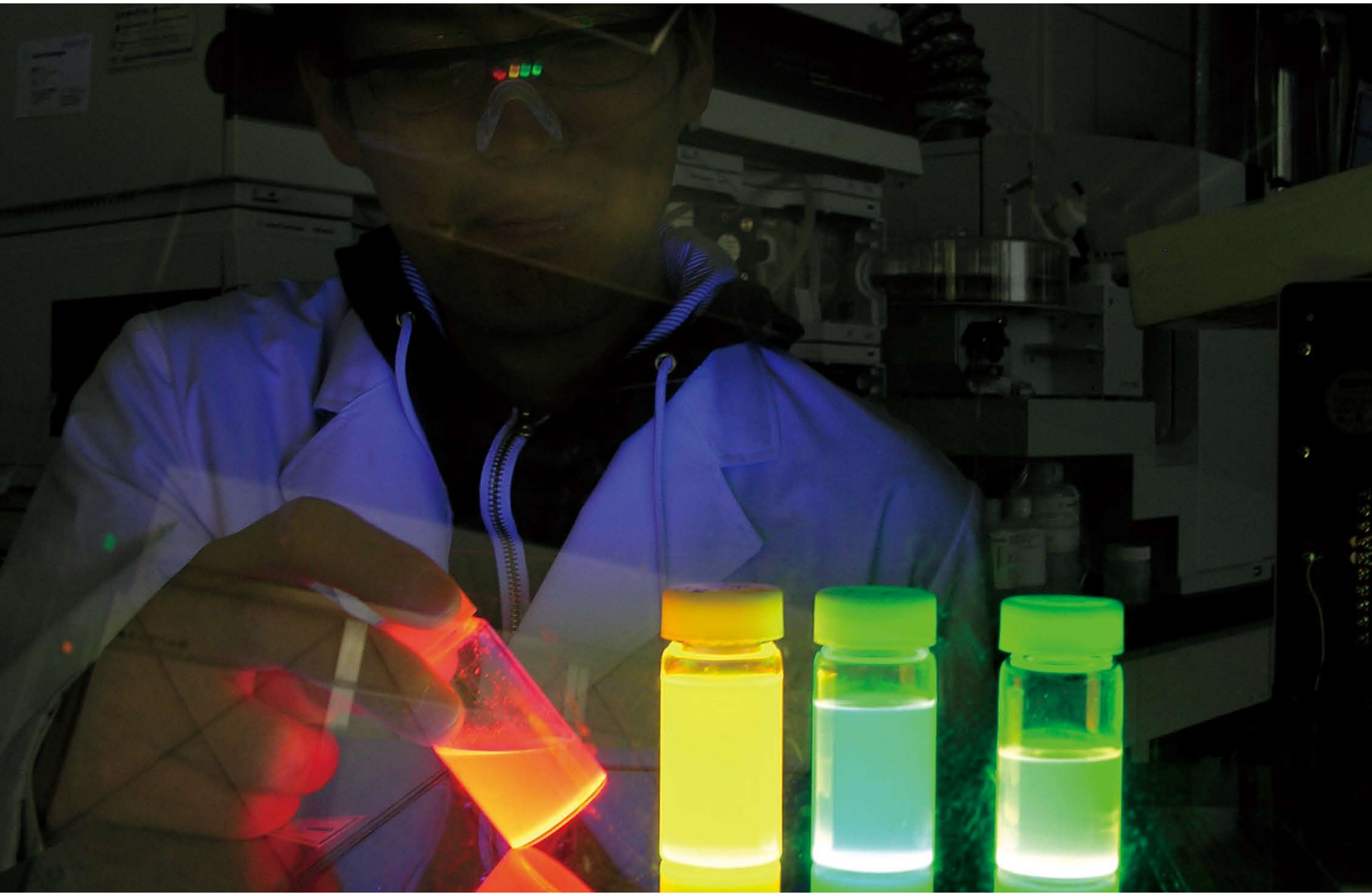
We are currently funding interdisciplinary projects, on interdisciplinary theoretical science, developing extreme precision instruments to explore fundamental physics with exotic particles, and integrated lipidology.

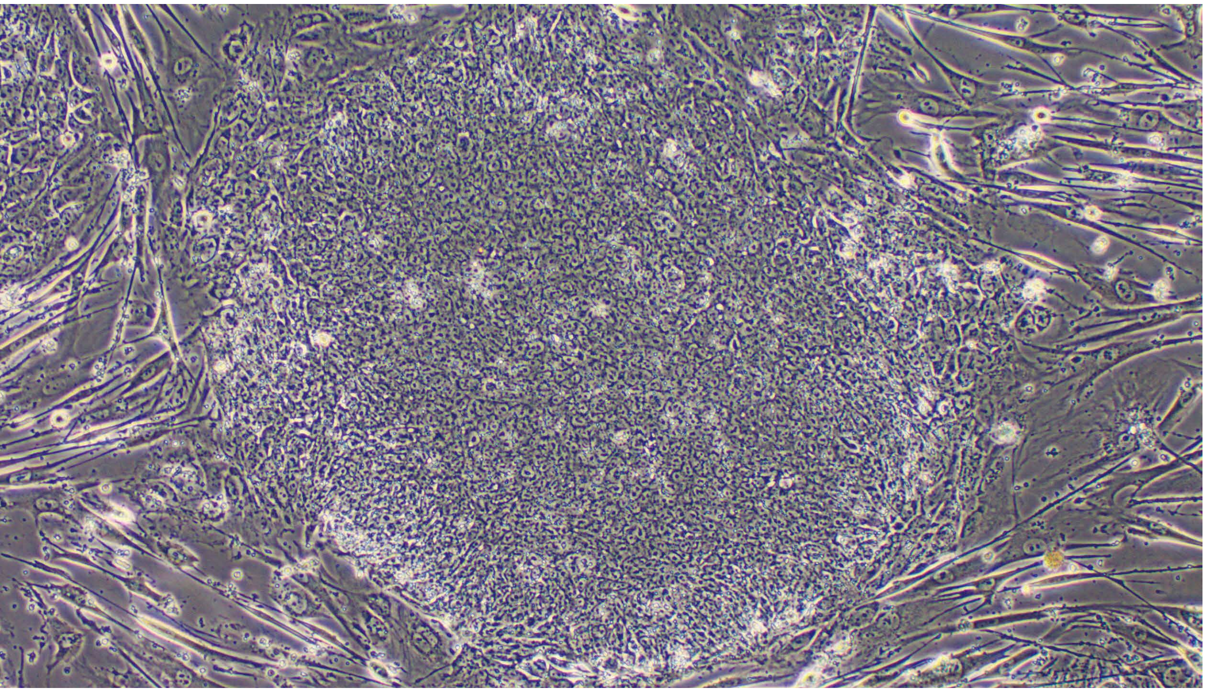
We have heard the personnel system will also be revised to ensure that the changes take root. Could you give us specifics on this?

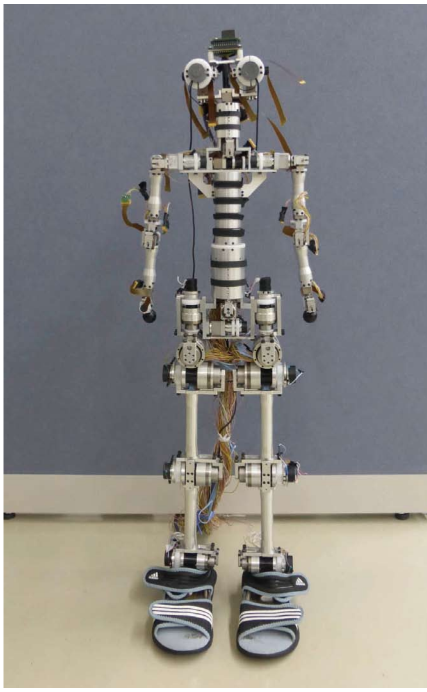
Kawai: The most important element of the change is that chief scientists, a key part of RIKEN's structure (see page 29), can now have their labs set up within the strategic centers. Chief scientists can also make proposals on future research directly to the president and the board of executive directors through the RIKEN Science Council. This gives the chief scientists working with the strategic centers an overall perspective of RIKEN, which can truly mobilize synergies within the organization. We hope that will lead to dramatic research breakthroughs.

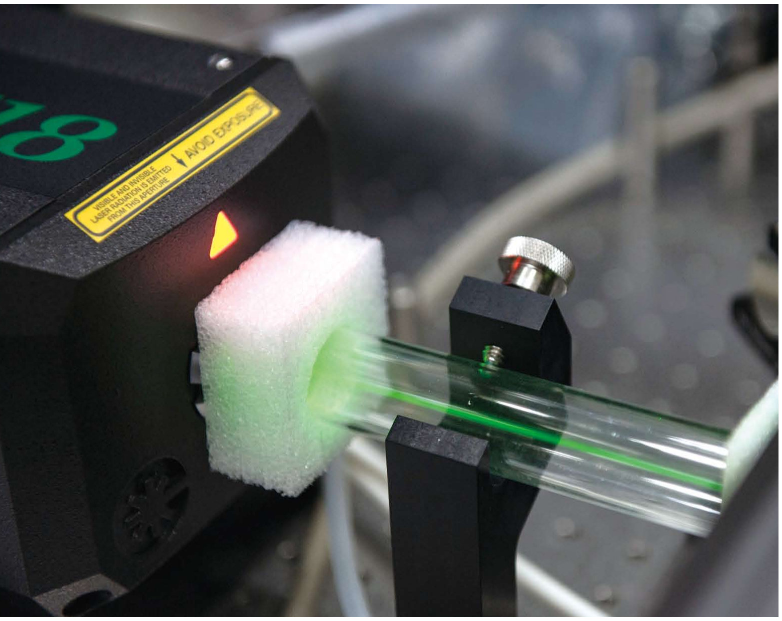
Research System of RIKEN

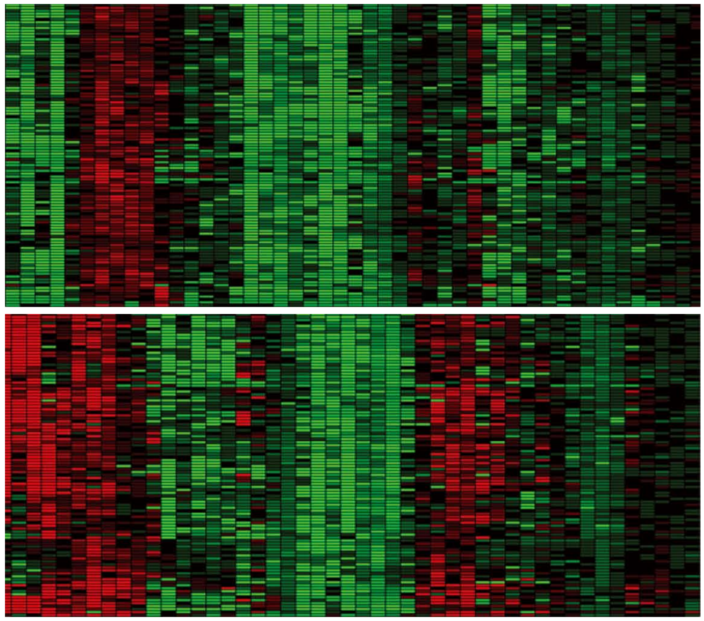


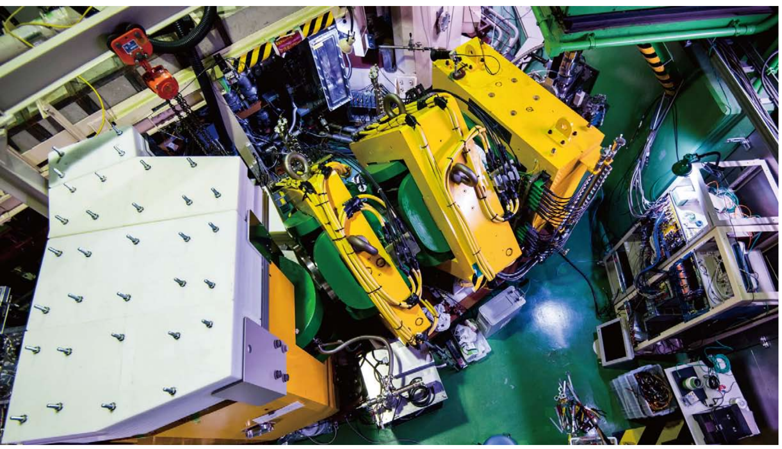


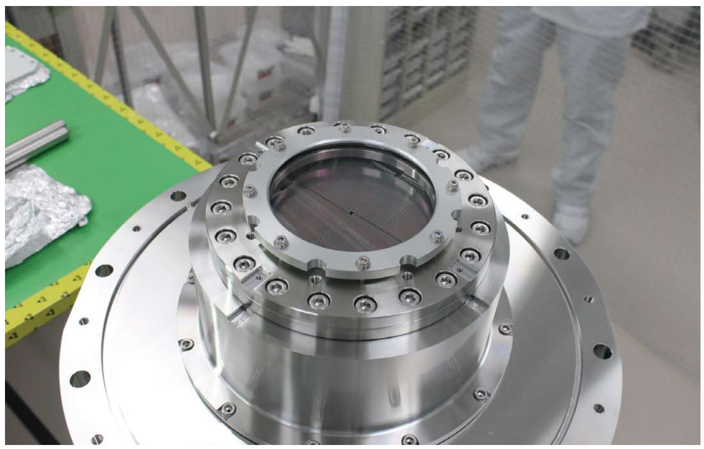












A sampling of some of the work being done at RIKEN's centers around Japan: (clockwise, from top left) quantum dot fluorescent probes from QBiC, a laser device at RAP, analysis from CLST showing gene expression in cells changing into macrophages, the Multiport CCD x-ray detector at the SACLA x-ray laser facility, Arabidopsis experimental plants growing at a CSRS lab, a learning robot at the BSI-Toyota collaboration in Nagoya, a human iPS cell like those being used in clinical research by CDB, and (center) the GARIS detector, which was used to detect element 113 for the first time.

Toward a better understanding of the mechanisms of life

Japanese science arguably has made its biggest impact in recent years in the area of Life Sciences and Biology. And RIKEN has been right at the heart of that research.

- Testing a treatment for blindness using stem cells
- Elucidating the evolutionary origin of the turtle's shell
- Designing molecules atom by atom
- Seeing the zebrafish brain lay down memory
- Lab-on-a-chip devices made from glass
- Contributing to liver research and unagi conservation
- Clones from a single drop of blood

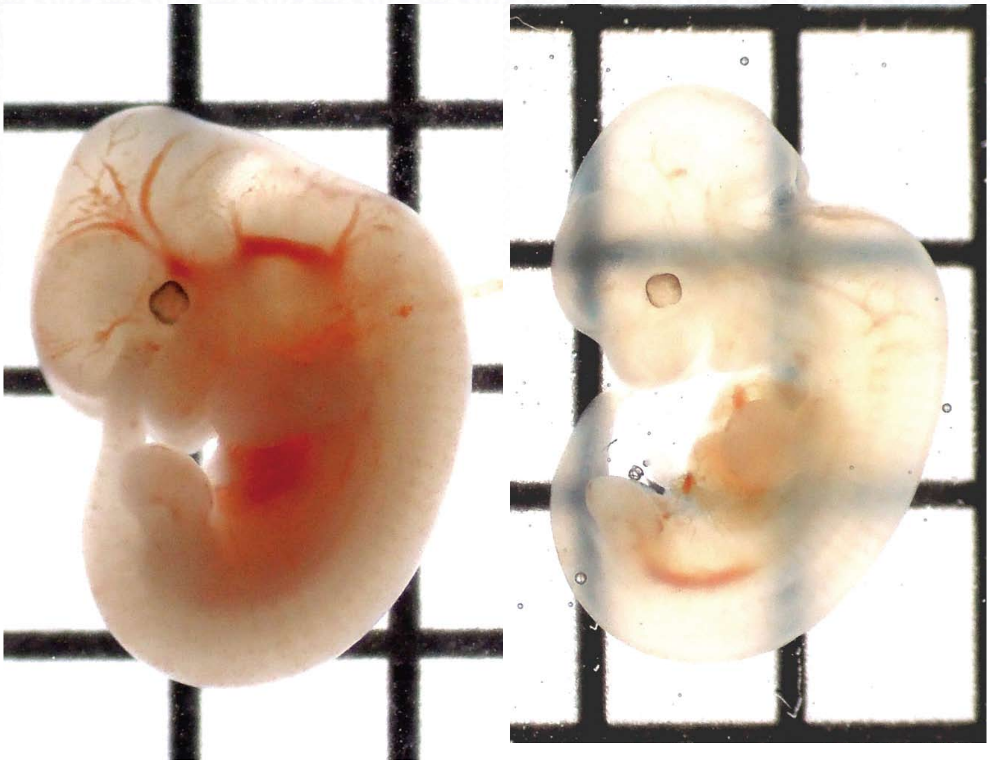
World-first clinical study using iPS cells

In July 2013, scientists at the RIKEN Center for Developmental Biology (CDB) received approval for plans to conduct a pilot safety study of an induced pluripotent stem (iPS) cell-based intervention for a serious eye disease. The study, led by Masayo Takahashi in collaboration with colleagues at the Institute for Biomedical Research and Innovation, will test the safety of iPS cell-derived sheets of retinal pigment epithelium cells, derived from the patients' own bodies, in a small number of patients with the wet form of age-related macular degeneration, which affects about 1% of people aged 50 and older in Japan. The researchers plan to perform the first investigational procedure in late 2014, and to follow up patients for three years.

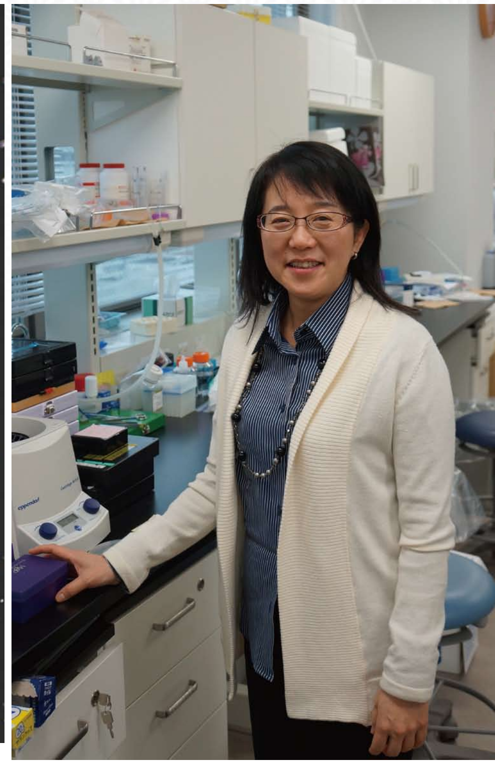
A number of other CDB labs also made important breakthroughs in the fields of development, regeneration and stem cell research. Team Leader Teruhiko Wakayama, who has since taken a professorship at Yamanashi University, reported the development of refined techniques for the cloning of mice by somatic cell nuclear transfer. Wakayama's team showed that mice can be serially cloned over as many as 25 consecutive generations, using nuclear material from one clone to give rise to the next, without any appreciable accumulation of genetic or epigenetic defects.

Work by Takeshi Imai's team resulted in another technological achievement in the area of tissue imaging. By treating embryos with a novel optical clearing agent, the lab found that they could render ordinarily opaque tissues transparent, opening up new possibilities in the visualization of neural circuitry.

Deputy Director Yoshiki Sasai's group built on its record of success with the induction of self-organized tissue from pluripotent stem cells, reporting the generation



The SeeDB solution makes tissue transparent.



Masayo Takahashi is leading the world first clinical research using iPS cells.

of cerebral cortex-like tissues from human embryonic stem cells in vitro. The lab showed that the novel techniques it first developed using mouse embryonic stem cells were scalable to the human system and could contribute to developing applications in such areas as drug discovery and screening.

Exploring the brain from neural circuits to mental illness

The RIKEN Brain Science Institute (BSI) in Wako, investigating the most complex but promising area of biology, the human mind, is highly international and multidisciplinary. BSI is involved in high-profile international research projects and also continued its development of a strong portfolio of collaborations with leading companies such as Toyota, Olympus, and Takeda Pharmaceuticals.

BSI comprises more than 40 laboratories conducting research in the areas of cell biology and development, physiology and systems science, cognition and theory, and brain diseases. The institute is among the most globalized centers in Japan with researchers from around the world and an international administration. The Sum-

Center for Developmental Biology (CDB)

The RIKEN Center for Developmental Biology is dedicated to the study of embryonic development, organogenesis, and regeneration in diverse animal models, with an eye to providing a robust scientific foundation for emerging fields such as regenerative medicine. Since its launch in 2000, CDB has become a leading institute with a strong record of high-impact publications and international engagement. Its most recent generation of labs is focusing on new questions and avenues in the study of development, with special focus on the process of organogenesis and the use of quantitative approaches.

mer Program remains one of the oldest and most prestigious student summer internships in neuroscience.

Notable published advances in the past year include the first visualization of the transfer of information into long term memory in zebrafish, and a mechanism for setting the polarity of neurons during brain development. In technology applications, researchers discovered a fluorescent protein from the Japanese eel unagi that will be useful for clinical assays. In the area of brain diseases, a BSI team created a series of transgenic mouse lines that will be licensed to the pharmaceutical industry to screen new compounds for Alzheimer's disease, and another group revealed a genetic control point for bipolar disorder. BSI also supports a major research group at the Massachusetts Institute of Technology called the RIKEN-MIT Center for Neural Circuit Genetics. In July, this laboratory led by Nobel Laureate Susumu Tonegawa reported the first experimental inception of false memories with optical genetic tools in mice, and another study describing a brain circuit that underlies conscious error correction.

Brain Science Institute (BSI)

The RIKEN Brain Science Institute is a global center of excellence in comprehensive research on the brain in both health and disease. The institute is exploring the fundamental capacity of the human mind for adaptive intelligence and social interaction—the foundations of society. Investigators study how the brain's myriad neural circuits control perception, cognition, and action; and how they go awry in diseases like Alzheimer's, depression, schizophrenia, and autism. The Institute features an interdisciplinary research system encompassing biology, medical science, biophysics, informatics, mathematical science, psychology, and linguistics. This integrative approach also underlies BSI's development of novel technologies and model systems for brain research. The Institute fosters international collaboration, policy discussions, and scientific communication.

Functioning at the cellular level

To observe and model molecular interactions inside living cells, researchers at the RIKEN Quantitative Biology Center (QBiC) have developed a number of innovative techniques.

In the past year, for instance, QBiC researchers have published a major advance in scrutinizing RNA, the messaging system of the cell. The inventory of RNA molecules varies not only between cells of different types, but also over time within the same cell as it performs different functions or responds to changing environments. The new Quartz-Seq method, developed with colleagues from CDB, can be used to distinguish cell types and cell phases with high reproducibility and sensitivity. Another example is progress on lab-on-a-chip devices, which are used for biochemical analyses and the processing of tiny volumes of solution. These devices are commonly made of plastic materials, which are neither inert nor wholly transparent. A QBiC team has overcome these problems by developing a method for fabricating similar devices from glass.

Using single cells to produce particular metabolic compounds is now commonplace. The optimum yield is often acquired by directing synthesis through specific biochemical pathways, which typically involves shutting

Urs Frey (second from right) and members of his lab at QBiC

down genes responsible for enzymes leading to alternative pathways. A new QBiC algorithm, known as FastPros, determines the most effective genes to knock out.

New technologies bring personalized medicine closer

In a related area, technologies to allow us to access information from the living body at the molecular level are opening the way to personalized medicine tailored to individuals. Last April, partly to build on that trend, RIKEN merged three of its research centers—Systems and Structural Biology, Omics Science, and Molecular Imaging Science—into the RIKEN new Center for Life Science Technologies (CLST).

The aims of the new collaborative and inter-disciplinary center are twofold: to develop key technologies that enable studies leading to new therapies and pharmaceuticals in the era of personalized medicine, and to undertake research and development into new technologies that will move us into the next-generation of life sciences. Initially, CLST will focus on three areas: designing biologically active molecules from the ground up, atom by atom; manipulating and regulating molecular functions in cells; and tracing how specific molecules move throughout the body.

The work of CLST encompasses a broad range of

Quantitative Biology Center (QBiC)

The ultimate goal of the RIKEN Quantitative Biology Center is to achieve “whole cell modeling”, which would give scientists an unprecedented understanding of dynamic living systems. In cells, molecules communicate with each other in elaborate, complex networks that regulate an extraordinary number of functions. By combining techniques that can measure molecular dynamics, model cellular environments, and simulate molecular and genetic networks, scientists aim to predict and control a cell’s behavior. Such control would revolutionize the life sciences and their applications, including fields like regenerative medicine and patient diagnostics.

physical, biological and clinical technologies. In the first year of its existence, it published work on the development of a new, thinner high-temperature superconducting insulated wire which can be used for magnets in a variety of devices including MRI and NMR spectrometers. FANTOM5, an international consortium led by CLST scientists provided the first holistic view of the complex networks that regulate gene expression across the wide variety of human cells. Also, functional PET imaging of the human brain has provided clear evidence of the association between neuroinflammation and the symptoms experienced by patients with chronic fatigue syndrome, usually of unknown origin.

Institute laboratories

A number of RIKEN's institute laboratories in the area of life sciences and biology undertake research at the molecular and cellular levels.

Mikiko Sodeoka, for instance, heads the Synthetic Organic Chemistry Laboratory, which in 2013 published a paper in which her team revealed it had developed a simple step-by-step synthesis method for trifluoromethylated amine compounds. The trifluoromethyl group has useful biological properties and is present in many pharmaceutical and agrochemical products, such as the antidepressant Prozac, the anti-inflammatory Celebrex and the herbicide Trifluralin. Despite this, few synthetic methods for producing these compounds are known.

Phospholipids are the main constituents of the cellular membranes in all organisms, from the single-celled Archaea to highly complex plants and mammals. That is one of the reasons why Toshihide Kobayashi's Lipid Biology Laboratory is important. For example, his laboratory cooperated with BSI researcher Atsushi Miyawaki's discovery that the unagi—a sea-going freshwater eel considered a delicacy in Japanese cuisine—harbors a fluorescent protein that can serve as the basis for a clinical test for bilirubin, a critical indicator of human liver function. The work also shed light on the mysterious and endangered unagi, and could contribute to its conservation.

Center for Life Science Technologies (CLST)

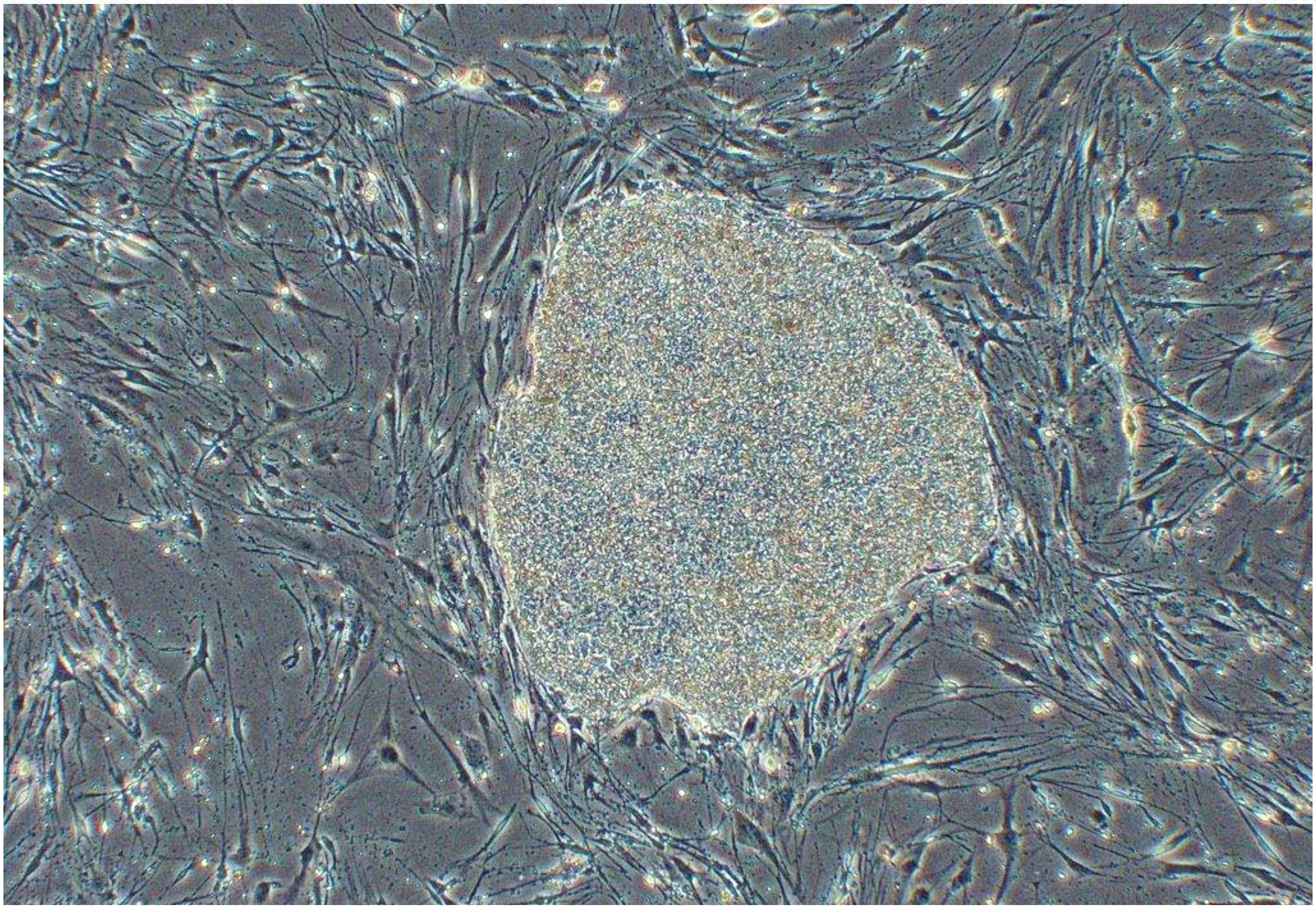
Next-generation life sciences and its applications are key to a healthy future for the world's population. Research at the Center for Life Science Technologies focuses on designing molecular structures at the atomic level; manipulating molecular function at the cellular level; and tracing molecular dynamics at the whole-body level. The Center aims to collaborate with the global life science community in developing key technologies to translate next-generation life science research into medical and pharmaceutical applications. It comprises the Division of Structural and Synthetic Biology, the Division of Genomic Technologies, and the Division of Bio-Function Dynamics Imaging.

Accessing bioresources

Underpinning the above work is the RIKEN BioResource Center (BRC) at Tsukuba, which is one of the world's largest repositories and distributors of model species.

BRC, established in 2001, makes available a broad diversity of resources including experimental mice, Arabidopsis plants, human and animal cellular materials, genetic materials, and microorganisms to researchers in academia and industry for experimental work.

Since March 2011, when it established the BioResource Building for Cell Research, BRC has also collected, preserved and distributed stem cell resources, particularly artificially-generated induced pluripotent stem (iPS) cells. This supports research not only into regenerative medicine, but also into drug design because it facilitates a better understanding of disease mechanisms.



iPS cells

In the past year, a team of BRC's own researchers succeeded in cloning mice from individual white blood cells taken from a single drop of blood. The technique shows that it is possible to prepare cells for cloning in a relatively noninvasive way, making it easier to create clones of infertile or "last-of-line" animals.

In a more traditional role, BRC has added to its resources the model cereal plant *Brachypodium distachyon*, a grass known as purple false brome. The family to which this plant belongs, the Poaceae, is one of the most economically important in the world, because it includes the cereals and temperate grasses.

BioResource Center (BRC)

The RIKEN BioResource Center in Tsukuba collects, preserves and distributes an extensive range of biological resources required for academic and industrial research. These include experimental mice, experimental Arabidopsis plants, human and animal cellular materials (including induced pluripotent stem cells; iPS cells), genetic material and microorganisms. These resources are used in studies ranging from basic research to the treatment of disease, health promotion, regenerative medicine, food production and even environmental conservation. The Center has been distributing to researchers within and outside Japan these materials since 2001, and provides extensive information about all of them, as well as training courses in how to handle them.

Working for a healthier world

RIKEN is pioneering a new era of medical research—creating a new center to focus on personalized medicine that will work alongside institute laboratories led by established investigators.

- Compound that could prevent acute blood cancer relapse identified
- A protein that reduces the severity of Alzheimer's disease
- Preparing for the threats from newly emerged viruses
- A genetic link to chronic obstructive pulmonary disease

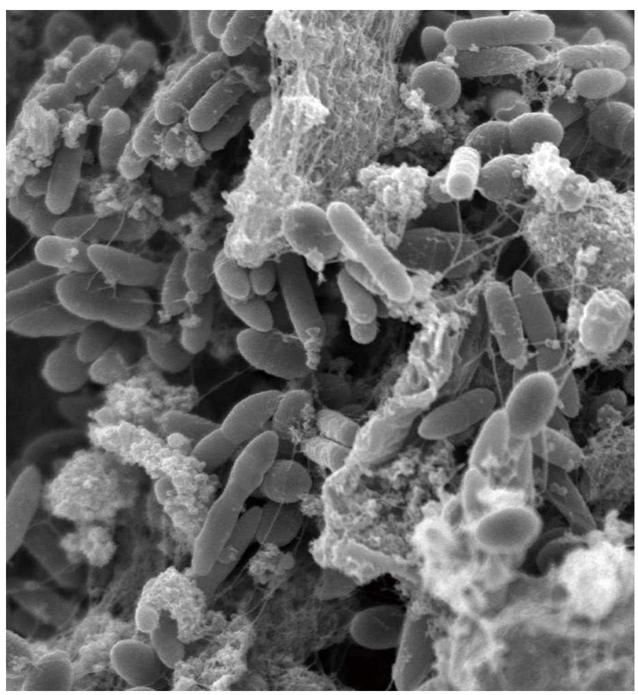
Last April, the new RIKEN Center for Integrative Medical Sciences (IMS) was formed from the merger of two of RIKEN's most important and productive centers, which undertook research into allergy and immunology and genomic medicine. The Center aims to usher in the new age of personalized medicine, by developing revolutionary medical therapies based on collaborative projects between researchers from different areas of science.

Bringing medical disciplines together

IMS includes 43 different research groups ranging from Statistical Analysis and Integrated Bioinformatics through Cell Functional Imaging to Digestive Diseases and Immunotherapy. It focuses on genomics, immunology, allergies, inflammation, endocrinology, and the new field of metabolomics. Its researchers are working on multi-disciplinary projects to develop personalized medicine and personalized preventive medicine that will allow us to lead healthier lives.

IMS research is founded on four innovative principles:

- transcend the different layers of body organization—molecules, genes, cells, tissues, organs—and view the body as an interactive system
- transcend species differences and use sophisticated "humanized" animal models and stem cells to study disease
- transcend human diversity by developing therapies which are personalized for individuals
- transcend traditional disciplines by emphasizing multi-disciplinary research teams and training.



Gut bacteria

The new center is already making an impact. It has published significant research on a compound that could prevent acute blood cancer relapse. Center researchers have also discovered bacteria in the human gut that can induce regulatory T-cells and have shown the potential of large-scale genetic studies for drug discovery by integrating the information provided by genome-wide association studies with existing datasets of genomic and biological information.

Tackling the world's medical challenges

Meanwhile researchers from RIKEN's many institute laboratories have continued to publish important advances in medical research. Mizuo Maeda and his team in the Bioengineering Laboratory, for instance, have shown that the human protein prefoldin can reduce the severity of Alzheimer's disease by modifying folding of the protein that causes it. Following a finding in 2012 on how anticancer drugs affect the shape of the tumor cells they target, scientists from the Antibiotics Laboratory have continued to work to identify new potential therapeutic drugs by examining small molecules produced by microorganisms, focusing on compounds that are involved in proliferation, differentiation and apoptosis.

Two interdisciplinary research laboratories are working in the areas of cellular and molecular biology and viral infectious diseases. The Viral Infectious Diseases Unit was established initially with HIV and AIDS in mind, but now extends to encompass leukemia viruses. It is

Center for Integrative Medical Sciences (IMS)

The RIKEN Center for Integrative Medical Sciences in Yokohama is contributing to the creation of new medical sciences for the future of human health. The new medical sciences combine the research of homeostasis that underpins our bodies and how its breakdown leads to disease with comprehensive analysis of the genomic diversity in individuals and identification of the genetic causes of disease and drug responsiveness. Our efforts are contributing to the advancement of personalized and preventive medicine for predicting individual diseases and the development of preventive methods and treatments tailored to the individual.

developing new methods to prepare for the threats arising from newly emerging viruses generally.

In the Systems Glycobiology Research Group, RIKEN is jointly investigating the biology of carbohydrate-protein complexes, known as glycoproteins, with Germany's Max Planck institutes. These molecules often play a role as membrane receptors and in internal cell signaling. In 2013, the glycobiology researchers discovered a genetic link to chronic obstructive pulmonary disease, a leading cause of death worldwide.

Center of Research Network for Infectious Diseases (CRNID)

Infectious diseases—be they established, like AIDS, malaria, hepatitis and TB, or emerging, such as SARS and bird flu—do not respect borders. That is why in 2005 the Japanese Government set up what became the Japan Initiative for Global Research Network on Infectious Diseases. Under this program, 10 Japanese research institutions have established 13 collaborative Research Centers in six Asian and two African countries. In parallel, RIKEN founded the RIKEN Center of Research Network for Infectious Diseases, which provides operational assistance to the research network, carries out surveys of research trends, organizes symposia, and coordinates and encourages collaborations within the network and outside.

Developing new materials and resources

Producing energy sustainably and using resources efficiently are critical to the future wellbeing not only of Japan, but the whole globe. With the recognition that a greater effort in energy and sustainability research is necessary, RIKEN in 2013 reorganized its research to meet this challenge.

- Exploiting the quantum properties of electrons, atoms and molecules
- Making almost limitless amounts of silk, collagen and other proteins using *E. coli*
- Developing a highly efficient iron nanoparticle-catalyst for hydrogenation
- Genome-wide discovery and information resource development of cassava plants
- Improving lithium batteries

On 1 April 2013, we launched two new multidisciplinary centers—the RIKEN Center for Emergent Matter Science (CEMS) and the RIKEN Center for Sustainable Resource Science (CSRS)—to tackle the significant work of developing new materials and resources.

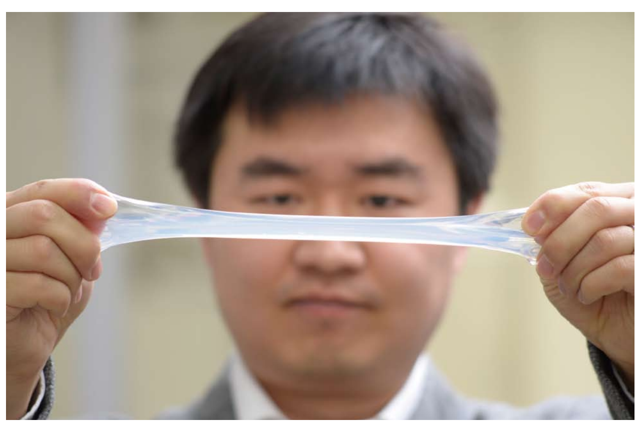
The power of many

CEMS brings together elements of physics, chemistry and electronics in a search for ways of producing energy sustainably without placing a burden on society or the environment. It has three major programs:

- strong correlation physics, in which combining huge volumes of electrons gives rise to strong electrical and magnetic properties
- supramolecular chemistry, where large numbers of molecules are linked together to meet desired ends
- quantum information electronics, which exploits the quantum properties of electrons, atoms and molecules.

A fourth division, the Cross-Divisional Materials Research Program, forges links between the other three. Although CEMS' work has a long horizon, in the short term it will contribute practical technology, such as highly efficient energy conversion devices and low-consumption electronics.

Almost immediately, CEMS scientists—a mix of senior and early-career researchers—have begun to pub-



Mingjie Liu of CEMS demonstrates an aqua material lish. In late May, for instance, a team led by Yoshihiro Ito and Hiroshi Abe showed a new process for synthesizing certain peptide molecules, the building blocks of proteins. They found that circular RNA molecules, as opposed to the typical linear strips of RNA, can be induced to produce almost limitless amounts of protein in the bacterium *E. coli*. The new technique can be used to synthesize biologically important proteins such as silk, collagen and epidermal growth factor.

Quantum physics for future technologies

In addition to CEMS, a number of institute laboratories are also working in the area of matter science. They include Akira Furusaki's Condensed Matter Theory Laboratory, which studies materials with strongly correlated electron systems, and their magnetism and superconductivity properties. Seiji Yunoki and Shinichi Hikino of the Computational Condensed Matter Physics Laboratory collaborated to come up with a practical proposal to transmit information over long distances by means of electron spin rather than moving electrons, helping to bring the era of spintronics closer.

The miniaturization of transistors is rapidly approaching the atomic scale, where even the tiniest imperfection can have a significant impact on performance. Keiji Ono and colleagues, from the Low Temperature Physics Laboratory led by Kimitoshi Kono, have developed a method for measuring the operational characteristics of single-atom 'quantum dot' transistors.

These three laboratory leaders also run labs in CEMS, demonstrating the flexible and collaborative nature of RIKEN's research structure.

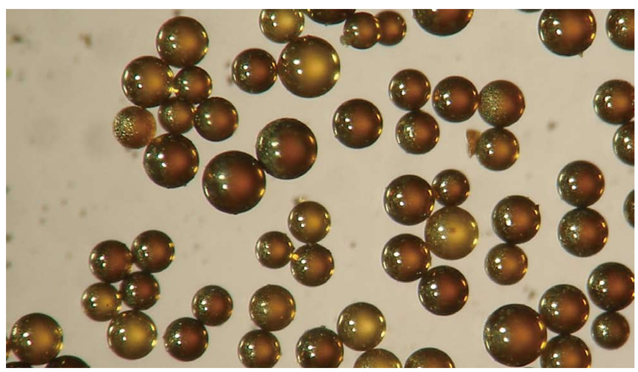
Sustainable solutions

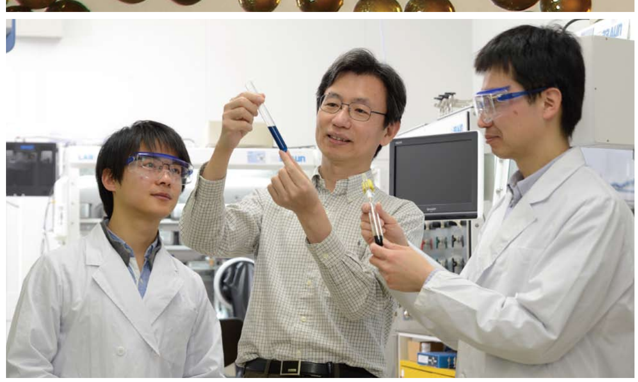
CSRS combines the inspiration of biology with a profound understanding of chemistry to develop useful and sustainable applications. It is already hard at work publishing a broad array of research results, from exploiting hydrothermal seabed vents for the long term generation of energy to increasing the drought resistance of crop plants.

CSRS integrates a number of fields in which RIKEN

Center for Emergent Matter Science (CEMS)

Scientists at the RIKEN Center for Emergent Matter Science are developing more efficient technologies to reduce energy consumption and the environmental burden of energy production in order to provide for humanity's energy needs and build a sustainable society. They're using physics, molecular chemistry and quantum electronics to generate novel materials and processes. New properties emerge in materials or molecules fabricated from interactions of large numbers of component electrons, atoms or molecules at the nanoscale. These new materials and processes can be used for technologies such as highly efficient energy-conversion devices and low-consumption electronics.





Top: Iron nanoparticles/bottom: Zhaomin Hou (center) of CSRS has particular strength, such as plant science, chemical biology and catalytic chemistry through four interdisciplinary projects focusing on the utilization of carbon, nitrogen, metallic elements, and the development of research platforms.

One of the first fruits of the new Center was a collaboration with Canadian scientists to produce a new iron nanoparticle catalyst that dramatically improves the efficiency of hydrogenation—a key chemical process used in a wide array of industrial applications. The iron-based catalyst replaces expensive rare metals and looks to be the forerunner of many similar products.

Later in the year, CSRS researchers and Colombian colleagues published information on more than 10,000 genetic alternatives in the widely grown crop plant cassava (tapioca). This library of gene mutations is an important resource for breeding this promising crop to feed growing populations in Asia, Africa and Latin America.

CSRS scientists also succeeded in creating a thermal water–seawater fuel cell next to an artificially created hydrothermal vent with collaborators from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). The experiment successfully demonstrated the potential of sustainable power generation on deep seabeds.

Generating and storing power

With several announced advances in the development of lithium-based batteries, 2013 has been a particularly productive year for the Byon Initiative Research Unit, one of several independent research laboratories involved in developing new materials and resources.

Because of their capacity to store energy, lithium-based batteries have been widely trumpeted as a likely power source for electric vehicles. Although widely used in consumer electronics, for safety and weight reasons the conventional lithium-ion battery looks likely to be replaced in vehicles by a lithium-oxygen design. Hye Ryung Byon and her team have now developed techniques for observing the electrochemical reactions taking place in a lithium-oxygen environment. They have found that the application of catalytic ruthenium oxide (RuO_2) nanoparticles can significantly improve the capacity of lithium-oxygen batteries for recharging. The Byon laboratory is also testing an aqueous lithium battery where the cathode is replaced by a dissolved iodine solution. It can be recharged up to 100 times without signs of corrosion.

Hye Ryung Byon (right) and members of her lab at Wako

Center for Sustainable Resource Science (CSRS)

The RIKEN Center for Sustainable Resource Science contributes to the development of sustainable production of energy, chemicals and biomaterials with integrated biological and chemical studies.

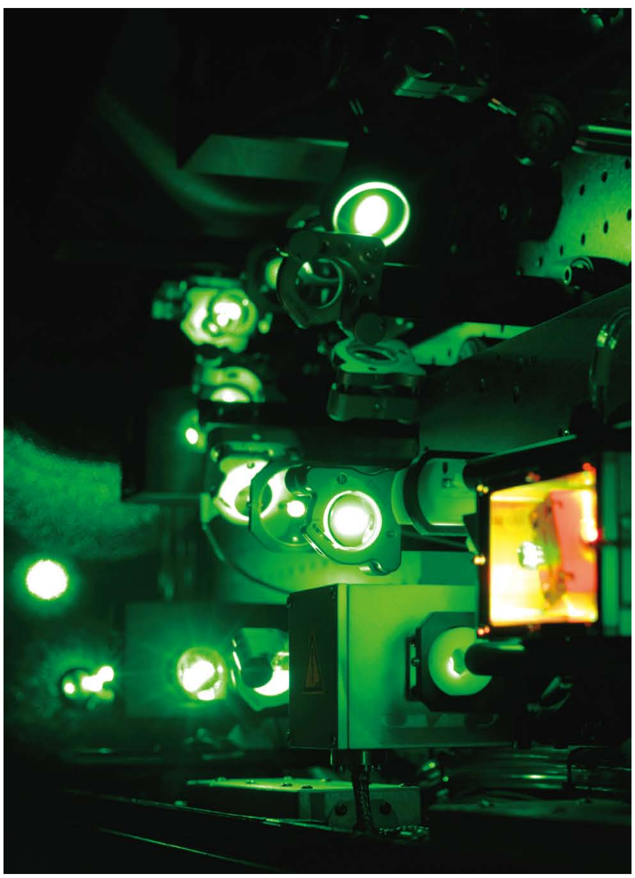
Four key center interdisciplinary projects involve:

- carbon—investigating ways to enhance photosynthesis in plants and developing catalysts to produce useful resources from CO_2
- nitrogen—developing new methods to save energy, for example by producing ammonia for fertilizer under ambient conditions
- metallic elements—researching how to create and use highly active catalysts and plants to recover rare metals, including from waste
- research platforms—using state-of-the-art infrastructure to provide metabolomic and chemical biology platforms to institutes in Japan and abroad.

Uncovering the mysteries of matter

From consumer electronics to bullet trains, Japanese industrial expertise has been founded on a profound understanding of physics. RIKEN's world-class facilities help to unlock the underlying principles of matter.

- Measuring the strength of hydrogen bonds
- A new "magic number" for stable atomic nuclei
- Detecting matter falling into a black hole
- Checking if a bridge is sound with neutron rays
- New materials to bend visible light



From using fluorescent x-rays to define the unique characteristics of precious Sasanian Glass, made in Iran between the 3rd and 8th centuries, to employing x-ray crystallography and nuclear magnetic resonance (NMR) spectroscopy to unravel how ion channel receptors function in the membranes of cells, RIKEN's SPring-8 synchrotron, the world's largest third-generation facility, has been applied to a huge variety of research in 2013.

It is just one, albeit the largest, of several sophisticated facilities that RIKEN operates involved in uncovering the mysteries of matter.

Synchrotrons explore molecular structure

For instance, alongside the synchrotron at RIKEN's Harima campus west of Osaka is the SACLA x-ray free-electron laser. 2013 was its first full year of operation and, in March, it was awarded the 42nd Japanese Industrial Grand Prix for its efficient design, which allows it to generate the world's shortest wavelength x-ray beams in a facility with an overall length which is a third to a fifth of its European and US counterparts.

Highlights of RIKEN's synchrotron research in 2013 included collaborative work between scientists at SPring-8 and Wageningen University in the Netherlands, which worked out the details of a protein-based, anti-viral immune system in bacteria capable of recognizing and destroying foreign genetic material. SPring-8 researchers, together with colleagues from Japanese government institutes, also unearthed a naturally occurring mineral, tetrahedrite, capable of contributing to environmentally friendly thermoelectric power generation.

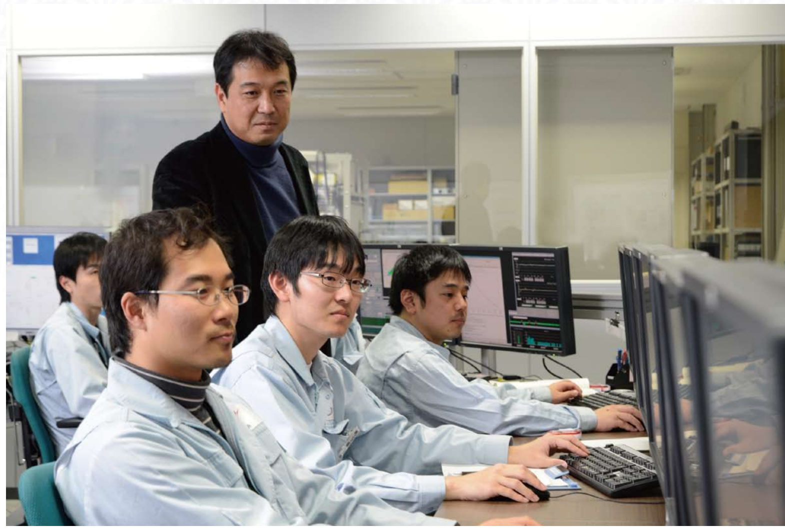
And an international team working at SPring-8 was able for the first time to measure the difference between the strength of the hydrogen bonds in normal "light" water molecules and in "heavy" water in which both hydrogen atoms are replaced by deuterium. Hydrogen bond strength has enormous ramifications for the role of water in biological reactions.

Meanwhile at SACLA, researchers succeeded in generating two ultra-bright x-ray laser pulses with different wavelengths. The time separation can be adjusted with attosecond (10^{-18} sec) accuracy, which makes them powerful tools to investigate the structure of matter and the dynamics of ultrafast physical processes and chemical reactions.

Looking into atomic nuclei

Studies in 2013 using the linear accelerator and GARIS detector in the RIKEN Nishina Center for Accelerator-Based Science (RNC) built on the stellar achievement of 2012 when the generation of element 113 was verified. These achievements included two major advances in determining the stability of atomic nuclei.

Just as specific numbers of electrons fill the energy levels or orbits known as shells, and full shells lead to stable, unreactive elements, so too protons and neutrons in the nucleus fill shells, with a full shell leading to a stable, spherical nucleus. The so-called "magic" numbers of protons or neutrons that lead to naturally stable nuclei are 2, 8, 20, 28, 50, 82 and 126.



Toru Hara watches over the control room at SACLA.

But evidence from experiments at the Nishina Center's Radioactive Isotope Beam Factory showed that in nuclei with a large imbalance in the ratio of neutrons to protons the rules governing these magic numbers begin to change, leading to instability. In a collaborative study with researchers at other institutions in Japan and in It-

SPring-8 Center (RSC)

Observing microstructures at the atomic and molecular level gives scientists new insight into physical and biological phenomena. This can be achieved using x-rays, which have a much shorter wavelength than visible light. The RIKEN SPring-8 Center, established at Harima in 2005, is unique in offering researchers both a synchrotron radiation facility, SPring-8, and an x-ray free-electron laser (XFEL) facility, SACLA, at the one site. In addition to medical applications, they can be used to examine microstructures at the atomic and molecular level. When SACLA opened in March 2012, RSC became only the second institution in the world to offer x-ray free-electron lasers for research.

aly, RIKEN physicists announced in the journal *Nature*, a new magic number of 34 neutrons in the unstable nucleus ^{54}Ca, where there are only 20 protons. Six weeks later, a RIKEN research team showed that the magic numbers 20 and 28 disappear from neutron-rich magnesium and silicon isotopes.

Meanwhile other researchers from the Nishina Center together with co-workers at several Japanese universities observed matter falling into a black hole in space using an x-ray detector aboard the Suzaku space-based observatory.

Seeing beyond the visible

Launched on 1 April 2013, the RIKEN Center for Advanced Photonics (RAP) has been charged with the task of making the invisible visible, by pushing the limits of the electromagnetic spectrum. Already RAP researchers are exploring the possibilities of imaging the very fast movement of atoms and molecules with even faster pulses of laser light; using optical microscopes with near-field optics to resolve the very small; employing neutrons and terahertz radiation to determine the internal structure of solids; and using metamaterials to process light in innovative ways.

But, says RAP Director Katsumi Midorikawa, such research should be undertaken always with a view to "contributing to society by developing practical applications". And that is certainly the case with work on developing a new, compact neutron source. The idea is that by using penetrative neutron beams, engineers can check the integrity of the internal structure of ageing infrastructure, such as bridges, better than with x-rays. This would demand, however, a portable source of neutron beams, which are typically produced in large facili-

Nishina Center for Accelerator-Based Science (RNC)

The RIKEN Nishina Center for Accelerator-Based Science on the Wako campus is a world-leading accelerator facility for theoretical and experimental nuclear physics research. It is named after Dr. Yoshio Nishina who constructed Japan's first (and the world's second) cyclotron at RIKEN in 1937.

The Nishina Center was established 2006 to promote research into the origin of matter by investigating the nature of nuclei and their constituents, elementary particles. That year, the Radioactive Isotope Beam Factory with its world-first superconducting ring cyclotron and superconducting radioactive isotope beam separator started full-scale operation. The Nishina Center collaborates with researchers around the world.

Satoshi Takeuchi (left) and David Steppenbeck (right) at the RIBF ties such as nuclear reactors or accelerators. Already the research team has developed an instrument just 15 meters long, small enough to be installed on a factory production line to inspect for faults.

Exploring antimatter

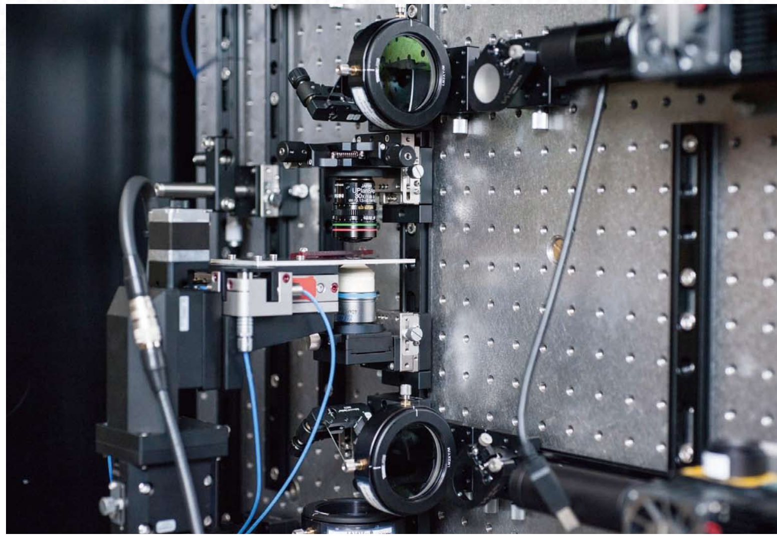
A RIKEN physicist is at the heart of a collaborative effort at CERN, the European Organization of Nuclear Research, to measure the magnetic properties of protons and antiprotons accurately enough to reveal the subtle differences between the two which may have led to our Universe being constructed overwhelmingly of matter, not antimatter. Stefan Ulmer heads the Ulmer Initiative Research Unit, one of many RIKEN independent research laboratories associated with uncovering the mysteries of matter. In 2013, the Ulmer laboratory began using a method that now makes it possible to observe the reorientation of the magnetic moments associated with single protons and antiprotons, and hence measure them precisely.

Lasers to low temperatures

Institute research laboratories at RIKEN span a whole spectrum of study from laser technology and metamaterials to low temperature and computational condensed matter physics.

Laboratory leader Hidetoshi Katori of the Quantum Metrology Laboratory, who researches in the area of quantum metrology, is working to develop a new device, called an optical lattice clock, that promises to define the second, which is used as our basic measurement of time, to even greater precision, and with this to shed new light on the structure of space and time.

And Takuo Tanaka from the Metamaterials Laboratory, in collaboration with Shoichi Kubo and colleagues at Tohoku University, has now demonstrated a scalable method to fabricate metamaterials that can interact with, bend and modify light at visible wavelengths.



Center for Advanced Photonics (RAP)

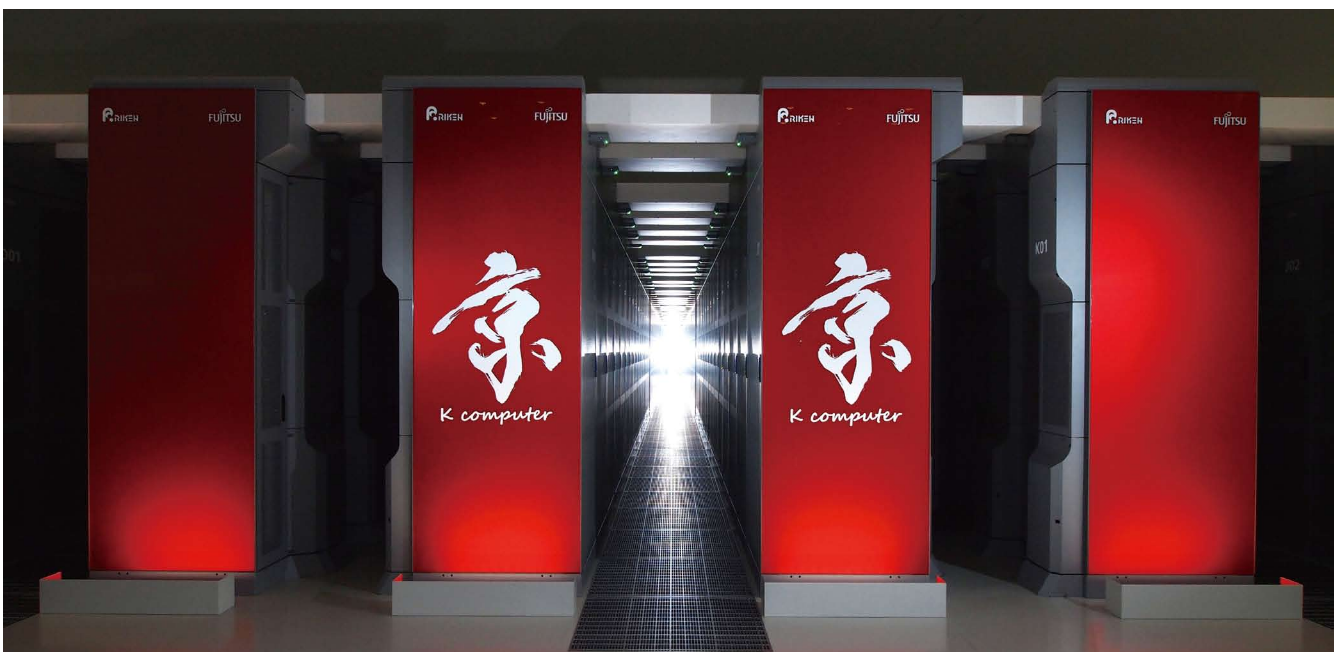
The RIKEN Center for Advanced Photonics is working to make the previously invisible visible by pushing the possibilities of light to the limit. Projects include: working with lasers that generate pulses as short an one attosecond (10^{-18} seconds), which makes visible the motion of individual electrons; developing near-field optics to overcome the diffraction limit of visible light, thus making the nanoworld visible; using metamaterials to manipulate the spectrum; and developing terahertz wave sources and detectors to open up new imaging, sensing and other technologies. Research at the Center focuses on making discoveries that will contribute to society through practical applications.

Harnessing computer power to simulate the world

When it opened for business in September 2012, Japan's K computer was the world's most powerful. Under AICS management, it is starting to prove its worth. Some of the exciting research being conducted with the K:

- Simulating neuronal networks, global atmospheric circulation and more in a wide variety of fields
- Receiving top honors at annual world supercomputing conference for overall performance and productivity
- Dramatically accelerating application performance with newly developed software
- Planning for a next-generation exascale supercomputer

Researchers are using the K computer to gain insights into the human heart, lithium-ion batteries, automobiles, methane hydrate, tsunami, dark matter, and much more. In 2013 the K computer has been used to conduct the most precise ever global atmospheric circulation model, with a grid spacing of less than a kilometer. This should allow more accurate predictions of potentially damaging storms. The supercomputer has also simulated the world's largest neuronal network of 1.73 billion nerve cells connected by 10.4 trillion synapses—about 1% of the human brain—



Advanced Institute for Computational Science (AICS)

With their high computational speed and exceptional precision in simulations, supercomputers have become indispensable to research and development in many fields. The RIKEN Advanced Institute for Computational Science was established in Kobe in 2010 to operate RIKEN's flagship supercomputer, the K computer.

The main objective of AICS is to develop and establish the science of forecasting based on computer simulation. This also involves undertaking ground-breaking research linking computer and computational science. AICS researchers have played a leading role, for instance, in generating software applications and making them available to other researchers worldwide as open source.

Advanced Center for Computing and Communication (ACCC)

The RIKEN Advanced Center for Computing and Communication is both a research organization and the group that manages RIKEN's high performance computing and communications infrastructure. In addition, the Center develops novel methods and software to integrate sequencing data and understand complex biological phenomena.

As infrastructure manager, the Center ensures the efficient organization and storage of the enormous amounts of data generated daily by scientific experiments at RIKEN. It provides RIKEN staff with user support and ICT services such as email, data storage and research databases as well as providing technical and R&D support to the supercomputer and bioinformatics programs.

demonstrating that it might well be possible to simulate a whole brain with a computer 100 times as powerful.

The K computer is the core technology of the RIKEN Advanced Institute for Computational Science (AICS) in Kobe and cornerstone of the High Performance Computing Infrastructure which links Japan's major supercomputers via high-speed networks. Not only does AICS manage and maintain the K computer, which can perform 10 quadrillion operations a second, it also makes the facility publicly accessible to researchers and industry.

AICS aims to improve forecasting by performing large-scale simulations on the K computer. This effort focuses on five key areas identified by the Japanese government: the life sciences, particularly drug manufacture; predicting global change to prevent or reduce the impact of natural disasters; new materials and energy creation; industrial innovation; and the origin of matter and the universe.

AICS was also selected to lead the development and construction of a next-generation exascale computer to follow the K.

HPCI Program for Computational Life Sciences (HPCI)

The RIKEN HPCI Program for Computational Life Sciences promotes R&D activities making full use of the powerful K computer, and establishes new infrastructure to promote computational science and technology. The R&D activities focus on large-scale simulations and analyses of biological processes for the prediction of biological phenomena. Processes such as molecular transport across biological membranes, protein/DNA interaction, and signal transduction can be analyzed and simulated using high-performance computers and provide invaluable insights into key processes in biology. The program is part of an initiative funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), aimed at yielding significant social and academic breakthroughs in five strategic fields, using Japan's powerful computing infrastructure.

Promoting innovation

RIKEN works closely with industry, applying its expertise and technology towards developing innovative and useful products.

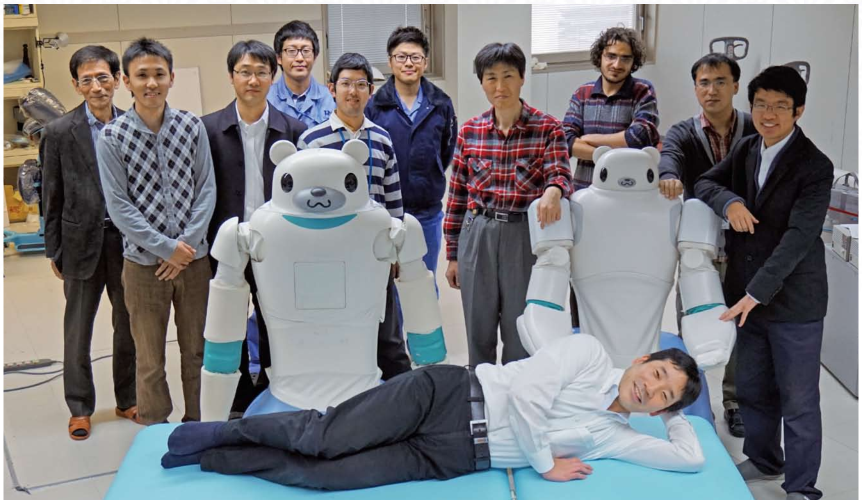
- From green technology to care robots
- New diagnosis kits
- Technology for artificial organs

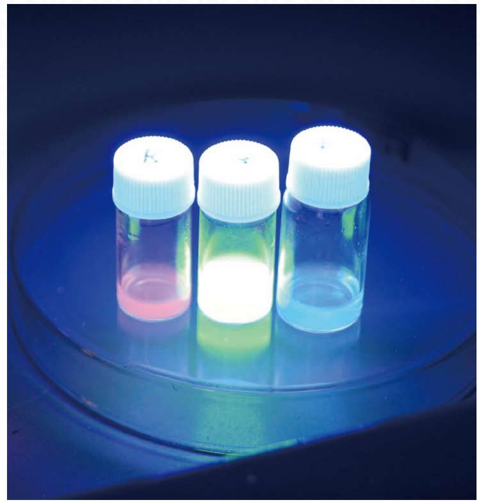
New drugs, green technology, simple and efficient medical diagnoses, care robots, improved decorative and crop plants—these are examples of the kinds of products developed in RIKEN's Innovation units, mainly in the RIKEN Research Cluster for Innovation. The laboratories in the cluster work closely with industry to ensure their research satisfies industry requirements and can be translated quickly into useful products.

The cluster includes a number of research programs for industry and society: Biomass Engineering, which generates strong new organic products and materials from plants; and Drug Discovery as well as Preventive Medicine and Diagnosis, which contribute to health research. These work in collaboration with the RIKEN In-

Drug discovery

The RIKEN Program for Drug Discovery and Medical Technology Platforms (DMP) assists the identification of new treatments for cancer and other diseases by promoting collaboration within RIKEN on the development of innovative pharmaceuticals and medical technologies. The Program is involved in all phases of development from the discovery of promising drug targets to the identification of potential lead compounds such as small molecules and antibodies. It supports the acquisition of intellectual property rights to drugs and technologies that can then be brought to the development phase. The program also provides support for translational research and the transfer of potential drug candidates to pre-clinical and clinical phases of drug development.





The RIKEN-Tokai Rubber RIBA development team in Nagoya

novation Center (RInC), which administers RIKEN's collaborations with industry (see page 28).

In addition to a Business Development Office, RInC operates several joint laboratories—such as the RIKEN-Tokai Rubber Industries (TRI) Collaboration Center for Human-Interactive Robot Research and the Tissue Response Control Materials Laboratory with Zeon Medical Inc., which develops biomaterials for fabricating medical devices and growing artificial organs. There are also industry-sponsored laboratories in areas ranging from the role of gut bacteria in digestion to the development of flexible electronics using organic semi-conductors. Other groups are working on efficient ways for generating electricity using solar and radiant energy and developing new crop plant strains incorporating mutations generated using beams of charged particles.

Preventive medicine

Disease prevention is more effective when any signs or symptoms of disease are detected early. Research groups in the RIKEN Preventive Medicine and Diagnosis Innovation Program (PMI) deploy a broad range of research resources in physics, chemistry, engineering, biology and medical science to develop and establish more efficient detection technologies. They are working on the discovery of new biomarkers, the development of detection technology for clinical practice, and the development of diagnosis kits.

The Program interfaces between the scientific advances made at RIKEN and colleagues in medical institutions, companies and research organizations, ensuring that scientific breakthroughs are effectively translated into clinical practice.

Biomass engineering

The RIKEN Biomass Engineering Program (BMEP) is pursuing a new engineering concept for using plant biomass as an alternative resource to petroleum, creating fuels and chemical materials such as bioplastics in an effort to achieve innovative new production processes. This commitment is helping to stimulate a shift from a consumption society based on the use of fossil resources to a sustainable society that uses recyclable plant biomass. To achieve this, the Program is pioneering the promotion of collaborations in green technology between RIKEN researchers, universities and industry, to create an innovation pipeline for the development of biomass-based resources.

Collaborations with industry

Collaborations with industry

RIKEN collaborates with industry in many different ways and we are always open to inquiries about potential collaborations.

Joint and sponsored laboratories, commissioned research, trainee internships to develop skills, shared facilities—RIKEN's profound commitment to working with industry is realized in many ways. It is most directly exemplified in our "Baton Zone" of innovative programs in which science and business work together. As the name suggests, it involves a handing on of knowledge from one partner to another. That process is managed by a dedicated group, the RIKEN Innovation Center, whose job is to support the transfer of RIKEN's scientific achievements into commercial products through partnerships with private companies.

The Baton Zone includes a Social Infrastructure Technology Development Program, and the Integrated Collaborative Research Program with Industry, under which joint research teams headed by company personnel are established for a limited time.

But there are many other ways in which industry can become involved with RIKEN, including licensing its patents—in 2013 RIKEN held 695 domestic and 679 foreign patents for technologies ranging from physics to medicine.

In the past year, collaborations between RIKEN and industry have led to some products including DNA detection kit and new materials.

Another important part of RIKEN's collaborations is the RIKEN Venture System. Under this, we contribute to industrial technology and people's everyday lives by using the new knowledge and new technologies that arise in the course of research at RIKEN on basic natural science. Among these companies are Megaopto Co., Ltd., which develops solid state lasers, and REGiMMUNE Corporation, which is working on therapies involving immunoregulation.

Institute Labs/ Global Research Cluster

Institute Laboratories

Institute laboratories are a key component of RIKEN's research structure. They are headed by Chief Scientists and other key institute personnel who are employed on a long-term basis, selected for their unique visions and potential for achieving breakthroughs that could open new fields of research based on a long-term vision covering decades.

The core of the institute laboratories is the Chief Scientist and Associate Chief Scientist laboratories. These labs are staffed by several tenured researchers with the potential to become future research leaders, who perform curiosity-driven research. The research is free and creative, spanning scientific disciplines including physics, chemistry, engineering, biology, and medicine. The objective of the laboratories is to make discoveries and inventions that will lead to rapid scientific advances and perhaps, open up new fields of endeavor that cannot be envisioned without stepping out of the box of current research fields. Chief Scientists enjoy considerable discretion in managing their laboratories, and can work in conjunction with the strategic centers to stimulate collaborations leading to pioneering projects in new research areas and to better coordination between scientists in different fields, helping RIKEN to mobilize its strength as a comprehensive research institution.

One example of such research activities is the Interdisciplinary Theoretical Science Research Group (iTHES), which was launched in April 2013 as a group of theoretical scientists in a wide range of fields, from physics and material science to biology and computational science, to seek useful methodologies that cross disciplinary boundaries, being applicable to both physics and biology, or theories that go beyond such borders. Thus, a major goal of iTHES is to create methodologies and theories that will open up new fields of science.

The MAXI instrument (right foreground) mounted on the ISS

Global Research Cluster

The global problems confronting modern society are complex. To solve them, a flexible cross-institutional framework for international collaboration is essential. RIKEN has accelerated its efforts to cultivate a first-class global hub for such innovative collaboration. The Global Research Cluster, a program coordinating international collaboration throughout RIKEN, provides strong support and leadership for the establishment of global institutional partnerships.

In the area of chemical biology, for instance, we are collaborating with the Max Planck Institutes in Germany, the Korean Research Institute of Bioscience & Biotechnology, and Universiti Sains Malaysia not only to promote understanding of various biological phenomena and drug discovery but also to strengthen exchanges of researchers.

RIKEN also seeks to transform the already global activities of researchers into cooperation at the institutional level and to diversify the means to fund our international initiatives. For example, the government of India has recently shown a desire to support RIKEN's collaborations with the National Center for Biological Sciences, Jawaharlal Nehru Center for Advanced Scientific Research and Indian Institute of Science.

Sharing world-leading large-scale facilities

SPring-8 and SACLA

Harima

SPring-8 in Harima is the largest third-generation synchrotron radiation facility in the world. We provide it to researchers from around the world to conduct advanced research in materials science, spectroscopic analysis, earth and planetary science, life science, environmental science and industrial applications. Complementing SPring-8 is the new SACLA x-ray free electron laser, which opened for research in March 2012. SACLA produces laser with very short wavelengths of light a billion times brighter and with a pulse width a thousand times shorter than the light available from SPring-8, making it an ideal instrument for observing extremely fast phenomena and small molecular structures. It can be an ideal tool for protein analysis, for instance.

Life Science Technology Platform

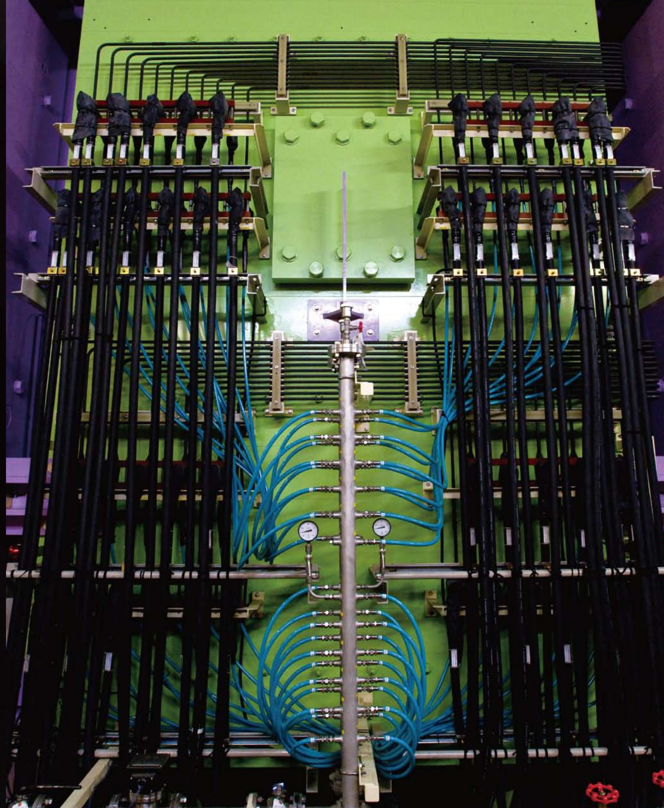
Yokohama/Kobe

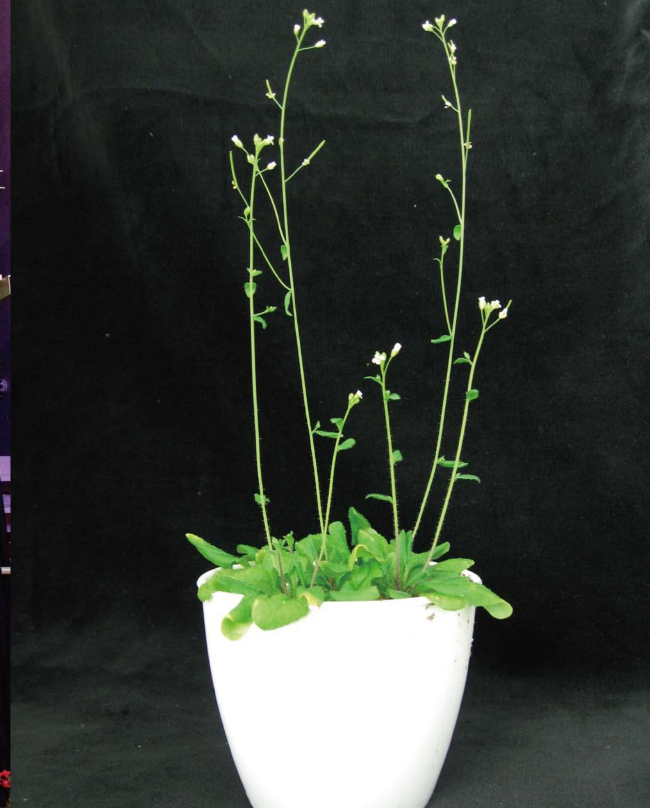
RIKEN has a rich set of advanced facilities used for research in medicine and other areas of life sciences. The NMR facility in Yokohama—one of the world's largest—operates ten nuclear magnetic resonance spectrometers, which are used for three-dimensional structural analysis of proteins and other molecules. These machines are, in addition to being used for medicine, used to promote technological innovation. The Genome Network Analysis Service, also in Yokohama, offers gene expression analysis and genomic sequencing using high-throughput next-generation sequencers. And the molecular imaging facility in Kobe, equipped with microPET scanners and cyclotrons for producing PET scanner tracers, as well as MRI and CT facilities, provides human resource development program for analyzing the dynamics of various molecules in the body.

K computer

Kobe

The K computer is a key technology of national importance funded by the Japanese government with RIKEN serving as the operating partner. In 2011, it became the first supercomputer in the world to achieve a LINPACK performance rating of 10 peta-





flops. Since its opening to outside users in the second half of 2012, the K computer has been used as a platform not only for basic research but also for commercial applications, thus contributing to the solution of problems confronting humanity. With its blistering speed, it makes possible simulations on a scale never attained before. Areas of research using the K include drug manufacture, new materials and energy, disaster prevention, manufacturing technology, and exploring the origin of matter and the universe. It is also made available to industrial partners for projects requiring its power.

Radioactive Isotope Beam Factory

Wako

The Radioactive Isotope Beam Factory (RIBF) in Wako is RIKEN's next-generation heavy-ion research facility. It provides researchers with the most intense ion beams in the world. At its heart lies a superconducting ring cyclotron—the world's largest—measuring 18 meters in diameter and weighing 8,300 tons, nearly as much as the Eiffel Tower. Recent upgrades to the facility allow for the generation of intense beams containing about 4,000 unstable nuclei, which range from hydrogen to uranium, making it possible to probe beyond the limits of the known nuclei. The facility is also used for heavy-ion breeding, allowing the efficient creation of new plant varieties.

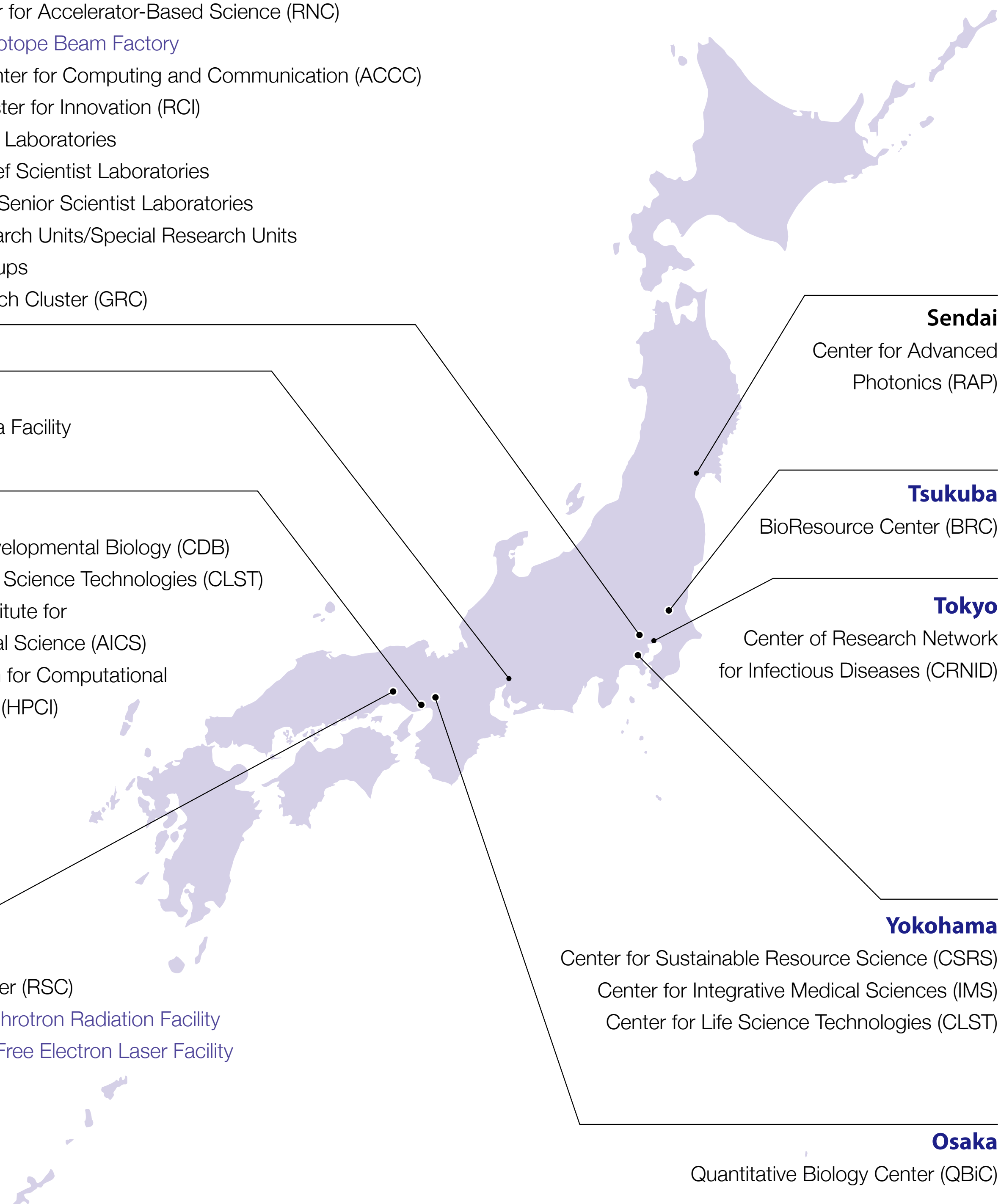
BioResource Center

Tsukuba

The BioResource Center in Tsukuba, established in 2001, has quickly developed into one of the world's most important repositories and distribution centers of biological resources for life science research. The center's reputation derives from its capacity to handle a wide range of living strains of experimental animals and plants, cell lines of human and animal origins, genetic materials, microorganisms and the associated bioinformatics. The center is particularly notable for providing human induced pluripotent stem (iPS) cells to researchers. Visit their website to find if there are resources that will be valuable in your research.

RIKEN's centers and facilities in Japan

Wako
Center for Emergent Matter Science (CEMS)
Center for Advanced Photonics (RAP)
Center for Sustainable Resource Science (CSRS)
Brain Science Institute (BSI)
Nishina Center for Accelerator-Based Science (RNC)
Radioactive Isotope Beam Factory
Advanced Center for Computing and Communication (ACCC)
Research Cluster for Innovation (RCI)
Chief Scientist Laboratories
Associate Chief Scientist Laboratories
Distinguished Senior Scientist Laboratories
Initiative Research Units/Special Research Units
Research Groups
Global Research Cluster (GRC)



Nagoya
RIKEN Nagoya Facility

Kobe
Center for Developmental Biology (CDB)
Center for Life Science Technologies (CLST)
Advanced Institute for Computational Science (AICS)
HPCI Program for Computational Life Sciences (HPCI)
K computer

Harima
SPring-8 Center (RSC)
SPring-8 Synchrotron Radiation Facility
SACLA X-ray Free Electron Laser Facility

Sendai
Center for Advanced Photonics (RAP)

Tsukuba
BioResource Center (BRC)

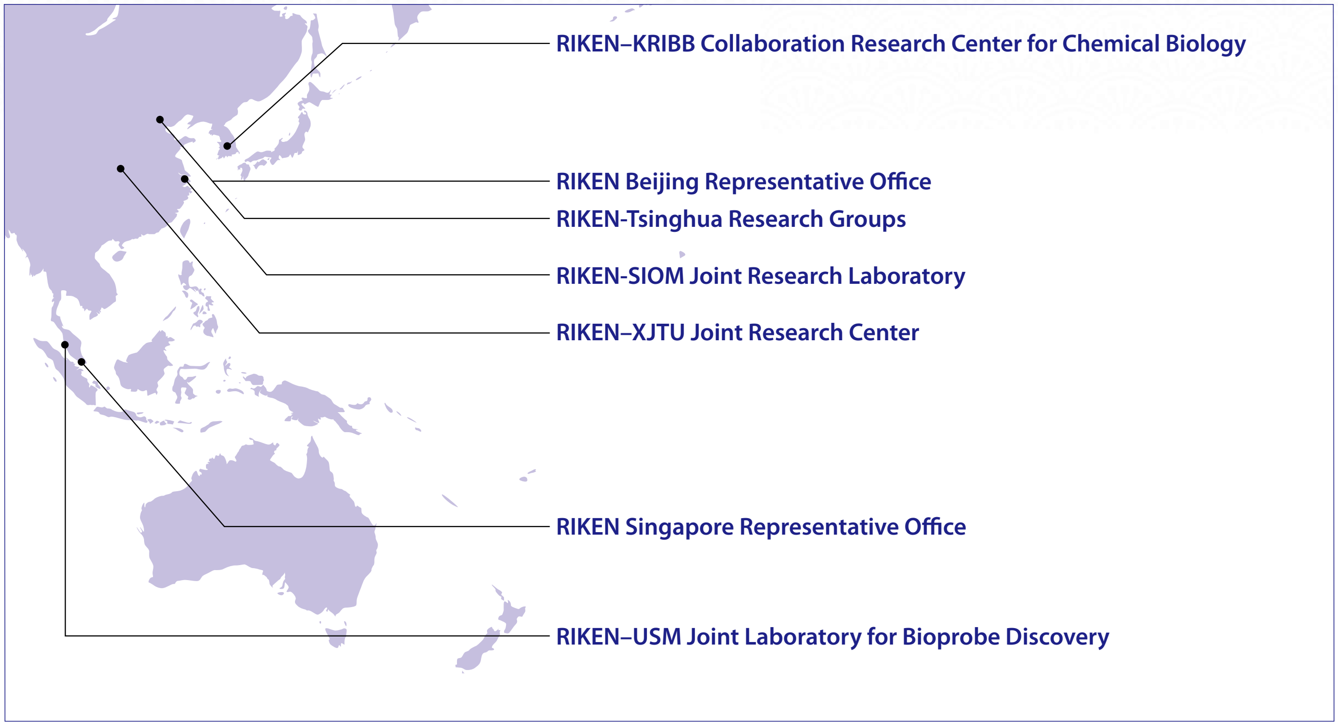
Tokyo
Center of Research Network for Infectious Diseases (CRNID)

Yokohama
Center for Sustainable Resource Science (CSRS)
Center for Integrative Medical Sciences (IMS)
Center for Life Science Technologies (CLST)

Osaka
Quantitative Biology Center (QBiC)

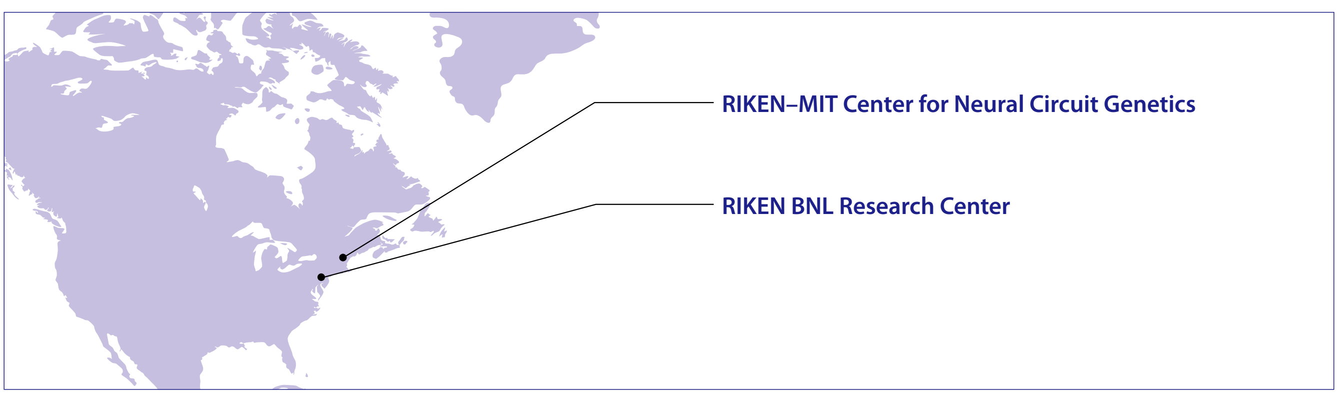
RIKEN's global presence

RIKEN in Asia



RIKEN in Europe

RIKEN in the USA



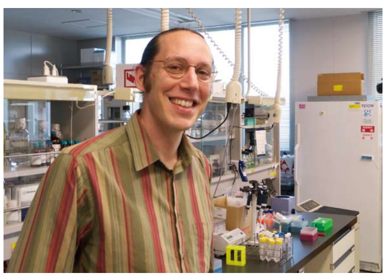
Staff perspectives

"Labs at RIKEN continually collaborate with one another, creating a stimulating environment for research and learning."

Satya Arjunan (Malaysia), Quantitative Biology Center

"RIKEN is a fantastic research institution in terms of its facilities and work environment."

Itoshi Nikaido (Japan), Advanced Center for Computing and Communication

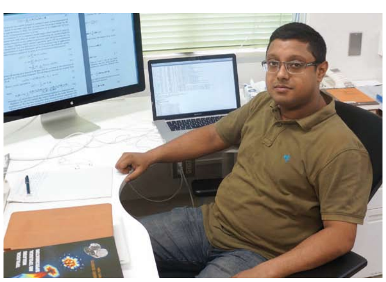


"RIKEN is a research organization where people can dedicate themselves to science with minimal distraction. The work environment is really conducive to research."

Charles Plessy (France), Center for Life Science Technologies

"RIKEN has a very open environment, where even young scientists are encouraged to discuss ideas and hypotheses. Here, people encourage discussion on 'real physics' and concentrate on how they can perform elegant science."

Jenny Lee (Hong Kong), Nishina Center for Accelerator-Based Science



"Settling in Japan can be a challenge for foreigners, especially due to language barriers. However, this is made a lot smoother by the RIKEN support services and the very friendly and helpful staff, who work very hard to make our stay as comfortable as possible."

Subhra Sen Gupta (India), Computational Condensed Matter Physics Laboratory

Support for researchers

In addition to its state-of-the-art research facilities and highly advanced technology, RIKEN offers an open, congenial environment for researchers from around the world, and a wide range of programs, services, and welfare benefits for all RIKEN employees, regardless of gender or nationality.

Support for Non-Japanese Researchers

A bilingual work and social environment

Many of RIKEN's laboratories are completely bilingual with Japanese and non-Japanese scientists and technical staff working side by side to achieve common goals. RIKEN also offers a bilingual administrative environment that provides needed information in a timely fashion in both Japanese and English. In addition, all full-time RIKEN employees are members of the RIKEN Employee Mutual Aid Society which sponsors a wide range of employee club activities and events, both cultural and sports-related.

Help staff

Friendly bilingual staff are on-hand at all major RIKEN campuses to provide information and support in healthcare, housing, childcare and schooling, and the practical issues of daily life.

Housing

The Wako campus has both single and family apartments while the other RIKEN campuses have a range of accommodation available, either on or off campus. For long-term stays, RIKEN will provide introductions to local real estate and, when necessary, assist with procedures.

Events

The Mutual Benefit Society organizes events on the different campuses to help our personnel build human relationships and enjoy their time off.

On-campus childcare

To help researchers focus on their work without having to worry about bringing their children off-campus, daycare programs are available for infants, toddlers and pre-school aged children at the Wako, Yokohama and Kobe campuses.

Special leave for family care

RIKEN offers special leave, in addition to its regular paid leave, for caring for sick children or other family members.

Personnel Support Coordinators

RIKEN is a strong advocate of gender equality and has Personal Support Coordinators who provide individualized guidance on RIKEN's support programs and services related to pregnancy, childbirth, childcare, and the care of sick or elderly family members.

Visit the Community page on the RIKEN website to find more detailed and practical information on life in Japan, immigration, housing, health, partners and spouses, and children.
www.riken.jp/en/community

Foreign Postdoctoral Researchers

RIKEN's Foreign Postdoctoral Researcher (FPR) program offers talented young non-Japanese researchers the opportunity to pursue innovative research under the direction of a RIKEN laboratory head.

Young researchers with creative ideas, and who show promise of becoming internationally active, can establish their careers with up to three years of funding, subject to favorable annual reviews. A generous remuneration package is supplemented with an annual research budget of ¥1 million (about US$10,000) for the host laboratory.

The program is open to foreign researchers in physics, chemistry, biology, medical science or engineering who have a doctoral degree and fewer than five years' postdoctoral experience.

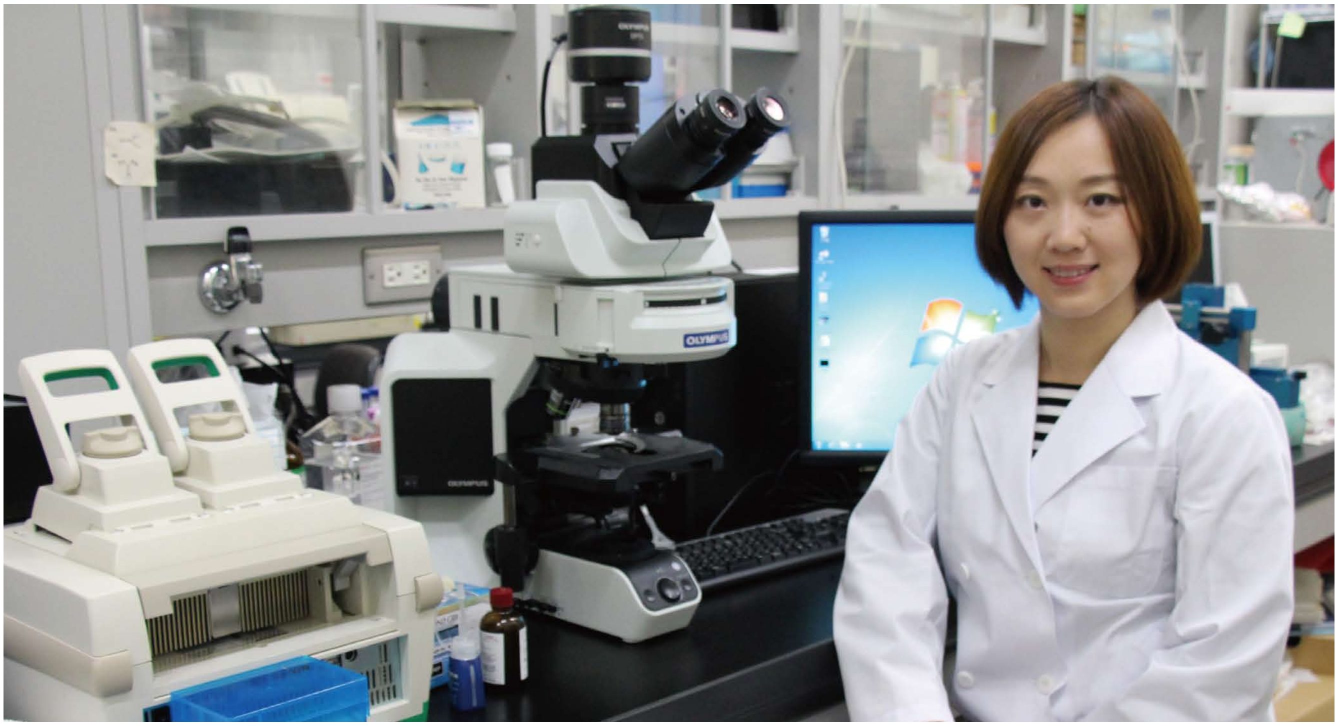
This RIKEN initiative aims to open up our facilities and resources to the world and create a stimulating research environment that places our organisation at the forefront of global science and technology.

"The FPR program has given me a unique professional opportunity. I highly value the program because the researcher's individual initiative is always encouraged, and even expected. A postdoctoral position at RIKEN is certainly a very rewarding research experience," says Giuseppe Lorusso, a physicist from Italy who works with radioactive isotopes.

More information:

www.riken.jp/en/careers/programs/fpr
www.riken.jp/en/careers/programs/fpr/ob

International Program Associates



RIKEN offers non-Japanese PhD candidates at participating universities the chance to undertake their doctoral studies in Japan under the supervision of a senior RIKEN scientist.

Each year RIKEN accepts about 100 students as International Program Associates (IPAs). Students enrolled, or about to enroll, in a PhD at one of the many Japanese and overseas universities participating in RIKEN's Joint Graduate School program are eligible to apply.

In March 2013, there were IPAs from 62 universities and four continents studying at RIKEN. They included students from Peking University and Shanghai Jiao Tong University in China, Pohang University of Science and Technology in South Korea, the Indian Institute of Technology in Mumbai, and the Karolinska Institute in Sweden.

Associates receive living expenses, a housing allowance and a round-trip airfare, as well as the benefit of international collaboration in their research and the chance to experience a different culture.

"As a foreigner I feel that RIKEN provides a very friendly living and working environment," says Tong Bu, a PhD student from China. "There are free Japanese language classes, announcements are made available in English, and there are many English-speaking support staff. I would encourage anyone considering studying for a PhD in Japan to think seriously about applying to become an IPA."

More information:

www.riken.jp/en/careers/programs/ipa

Schools/visiting scholars: For visiting researchers

In addition to the Foreign Postdoctoral Researcher program and support for International Program Associates, RIKEN supports visiting researchers through the Associate Chief Scientist Program, the Special Postdoctoral Researcher Program, and collaborative research and exchange programs.
RIKEN also runs many summer schools, which give visiting scientists and students the opportunity to learn from eminent researchers.

Brain Science Institute Summer Program

The BSI Summer Program is a stimulating opportunity for young researchers to study brain science in Japan. Graduate neuroscience students from all over the world can participate in either a two-month laboratory internship at a BSI laboratory, or an intensive two-week lecture course given by distinguished international scientists.

More information: www.brain.riken.jp/en/summer

Nishina School

The Nishina School offers selected students from Peking University, Seoul National University and University of Tokyo the opportunity to acquire hands-on experience in theoretical and experimental nuclear physics in a two-week summer school at the Nishina Center for Accelerator-Based Science (RNC).

Center for Integrative Medical Sciences International Summer Program

The RIKEN IMS International Summer Program (RISP) aims to provide PhD students and young postdoctoral researchers from around the world with the opportunity to learn about recent research in immunology. It takes place over one week at the IMS facility in Yokohama and includes presentations from internationally distinguished immunologists and each participant.

More information: www.ims.riken.jp/english/jobs/summer_program.php

Cheiron School

With the help of the Asia-Oceania Forum for Synchrotron Radiation Research (AOFSRR) RIKEN offers the Cheiron School to students, young scientists and engineers from forum member countries. Participants learn about synchrotron radiation science at SPring-8, the world's largest third-generation synchrotron facility.

More information: www.spring8.or.jp/en/students#cheiron

Organizational governance: High governance standards

Members of the 8th RAC in 2011

President Noyori and RAC chair Rita Colwell

As a taxpayer-funded body, RIKEN places great importance on proper governance and accountability. We have strong systems in place to ensure that our research and operations meet the highest international standards.

The key component in this governance structure is the RIKEN Advisory Council, a group of distinguished scientists from around the world specializing in all the major research fields that RIKEN is engaged in. The Advisory Council meets every two or three years to evaluate activities and propose new directions for research and operations. RIKEN was the first Japanese institution to establish such an international evaluation system.

This structure is replicated at the level of RIKEN's centers, each of which has a similar committee that evaluates and proposes activities in its own field.

Internally, the RIKEN Science Council meets regularly to advise the president on pressing issues. It is composed of Chief Scientists, a system unique to RIKEN in which outstanding researchers are chosen to perform bottom-up research in various fields, going beyond the divisions of centers and scientific disciplines. This gives them a panoramic view of RIKEN's activities as a whole and, through the Science Council, lets them propose new fields that the organization should pioneer.

To ensure RIKEN's science is always rigorous and ethical, we have adopted a set of Regulations for the Prevention of Research Misconduct, with a dedicated office charged with ensuring that all employees comply with these regulations and others such as those governing harassment. This year our regulations are being put to the test with a high profile inquiry into RIKEN papers on mechanically turning mouse cells into stem cells.

Toward a greener world: RIKEN's environmental activities

- High yields of bioplastics from cyanobacteria
- Energy from the bottom of the sea
- Low-energy production of ammonia for fertilizers
- Environmentally friendly pesticides
- Acting locally for global sustainability

RIKEN is a comprehensive research institute in the natural sciences. We contribute to environmental improvement through our research, which is directed towards a sustainable future, and through our everyday conservation efforts.

In April 2013, RIKEN founded the Center for Sustainable Resource Science (CSRS) to focus on green innovation. Scientists at CSRS, and at other RIKEN centers, have made a number of discoveries that could help in our quest to create a greener world.

Alternative materials and fuels

Reducing society's reliance on fossil fuels is an important step towards sustainability, and CSRS scientists are researching promising alternatives.

One such efforts is using cyanobacteria to produce bioplastics. To date this has been a costly process compared with making plastics from fossil fuel, but CSRS scientists succeeded in achieving a threefold increase of the yield of PHB bioplastics by modifying cyanobacterial genes.

And, in January 2014, CSRS researchers and collaborators at Universiti Sains Malaysia devised a way to produce bioplastics from cyanobacteria with photosynthesis alone. This could pave the way to creating bioplastics in a safer, cleaner way, without the need of chemical inputs.

These research projects could deliver future bioplastics at a lower cost and with a smaller burden on the environment than current processes.

The Center has also generated electricity from a fuel cell placed next to a geothermal vent on the bottom of the ocean off Okinawa. The electricity is generated from the difference in water temperature between the regular ocean water and the hot water emitted by the vents.

Sustainable production methods

Several research streams are working towards more sustainable industrial production methods that use less energy and resources and produce less pollution. In June, Center scientists announced that they had devised a catalyst to split nitrogen molecules and attach them to hydrogen under ambient temperature and pressure—a process required to produce ammonia, the basis for fertilizers and other industrial products. The current process, using high temperature and pressure, consumes 1% of the total energy produced artificially in the world.

In a similar advance, researchers from CSRS collaborated with colleagues from McGill University in Canada to develop a catalyst that uses iron rather than rarer and more polluting heavy metals to promote the hydrogenation chemical process used in many industrial applications.

Agricultural methods are also the focus of research efforts at RIKEN: to develop plants that are productive in poor water and nutrient conditions.

Helping to address drought and pests

In July, researchers from CSRS announced the discovery, in collaboration with the University of Tokyo and Saitama University, of an important mechanism that first allowed aquatic plants to evolve to adapt to the relatively drought-like conditions of dry land. They were able to create drought-resistant plants by switching on a specific gene, a mechanism which could be important in a future world with serious water shortages.

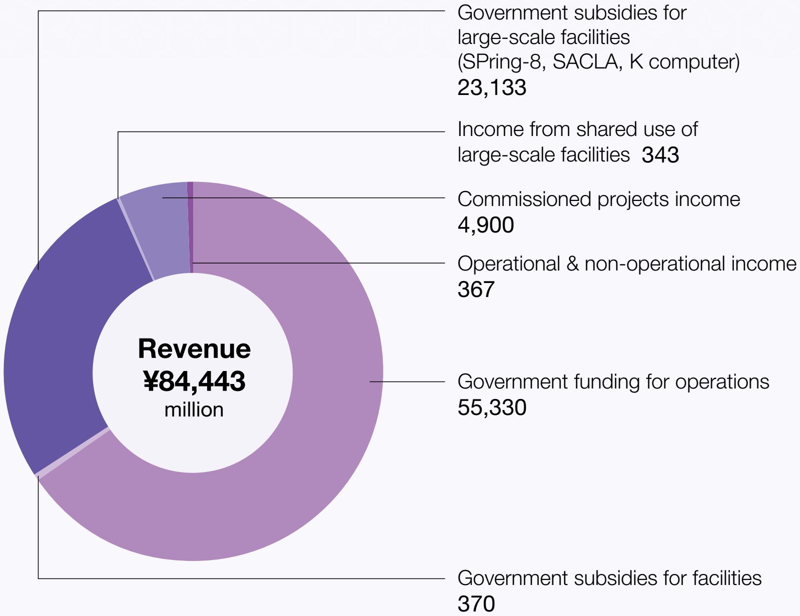
Another important achievement, in this case by scientists from the RIKEN Innovation Center, is the development of SaFE (Safe and Friendly to Environment) pesticides, which are already being used by farmers. These pesticides are based on ingredients that can be safely consumed by humans, so are friendly to the environment yet still protect valuable crops from pests. At the Nishina Center for Accelerator-Based Science, researchers are developing new plant varieties using heavy-ion breeding. This technique, which was developed at the Nishina Centre, is mostly used in Japan. It involves using heavy-ion beams to induce mutations in target samples in order to create new plant cultivars. The research group has developed a strain of rice that is highly resistant to salt, and a fast-growing variety of the edible seaweed wakame. Past achievements include new varieties of cherry blossoms.

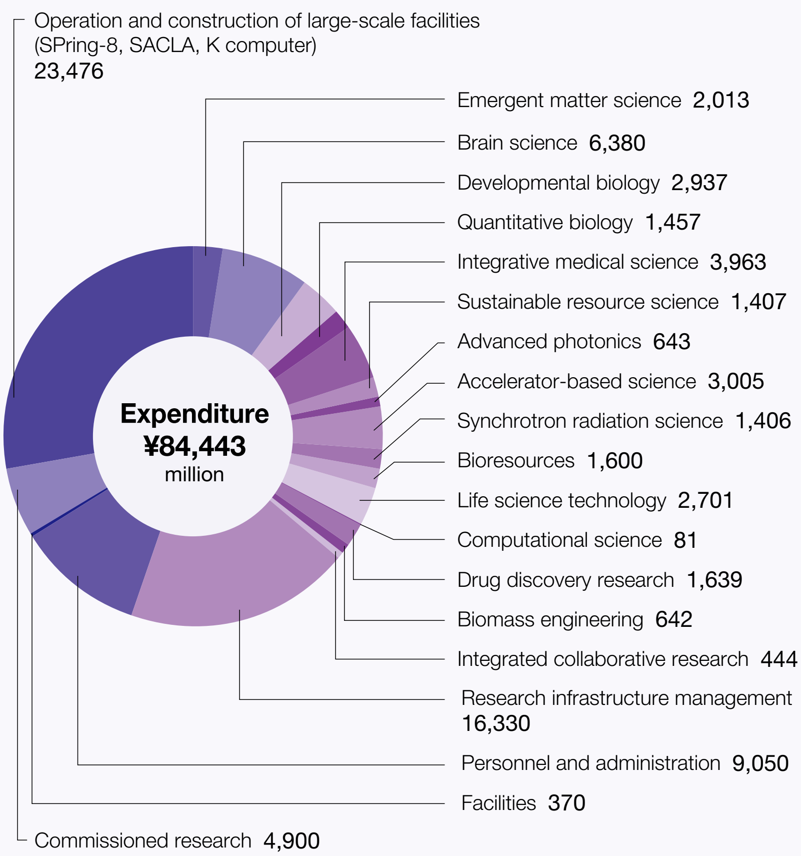
Local action

At RIKEN, we are also contributing to a greener society through everyday efforts of our management and staff. Since 2011, all RIKEN campuses have been closed down for a three-day period in the summer to conserve electricity. To encourage both energy conservation and good health, we encourage employees to wear comfortable clothing suitable to the season and to use stairs and public transportation when possible.

The parts of the leaves sprayed with SaFE pesticides are free of infection

Budget 2013





RIKEN is a large organization, with a budget of just over 80 billion yen. The majority comes from public funding, although we also win a significant portion from competitive external funds.

A significant part of our budget is allocated to personnel expenses and to the budgets of the large centers that make up our organization. In addition, a portion is allocated to important projects within RIKEN, especially multi-disciplinary collaborations, under the Competitive Program for Creative Science and Technology. This program aims to encourage RIKEN scientists to pioneer new fields of research.

We use our budget to conduct research in a wide range of fields and to manage large research infrastructure projects, which today include the K computer in Kobe, the SPring-8 synchrotron facility and SACLA X-ray free-electron laser in Harima, the Radioisotope Beam Factory in Wako, and the BioResource Center in Tsukuba.

Our skills in this area led to RIKEN being selected by the Ministry of Education, Culture, Sports, Science and Technology to manage Japan's future exascale computing project.

Research output and patents

Each year, RIKEN scientists publish between 2,000 and 3,000 papers covering all areas of the natural sciences, many in top-rated international journals such as *Nature* and *Science*. Testifying to the high quality of our work, more than 20 percent of these papers rank in the top ten percent of publications worldwide in terms of citations. And more than 3 percent are in the top one percent of all papers.

Our breakthroughs translate into much more than journal papers, however. We also actively encourage our researchers to patent their discoveries and we protect this intellectual property portfolio to ensure that industry can use it to improve people's lives. In 2013–2014, RIKEN scientists filed for 352 patents, and 624 patents were licensed to companies, providing RIKEN with 96 million yen in revenues to supplement our budgetary outlays.

Some of our recently licensed technologies include a high-tech blood pressure monitor, new varieties of Japanese cherry blossom trees, and an environmentally friendly line of pesticides.

In the Outreach section of the RIKEN website, we highlight those of our patented technologies that are available for licensing.

Patents

In 2013, RIKEN held
695
patents in Japan, and
679
foreign patents.

RIKEN filed for
352
new patents during the year based on our research.
624
patents were licensed.

RIKEN earned
96 million
yen in income from these patents

Research output

RIKEN Researchers published
2,629
papers in 2013

By citation,
25% ranked in the top 10%, and
5% ranked in the top 1%
of all papers published worldwide in 2012

Source: Thomson Reuters Web of Science/Science Citation Index Expanded, May 9, 2014

RIKEN's work force

RIKEN is an international organization with an increasingly diverse staff, thanks to our global recruitment programs.

The number of international researchers has risen significantly in the past ten years and now more than 15 percent of RIKEN's 2,000 researchers come from outside Japan. Most are from nearby countries, including China and Korea, but a significant number have come from Europe, North America, and other countries of the Asia-Pacific region.

Through this focus on international recruitment, RIKEN has become a leader among Japanese research organizations in employing non-Japanese staff. We aim to increase the proportion of foreign research staff further—to closer to 30 percent.

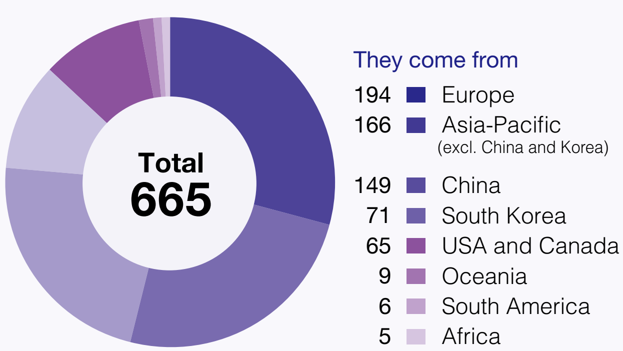
We are also making strong efforts to increase the number of women at RIKEN. In Japan, women are generally underrepresented in the science and technology world, but RIKEN has shown leadership in this area by implementing a variety of programs to encourage the recruitment and retention of female staff.

Our work force

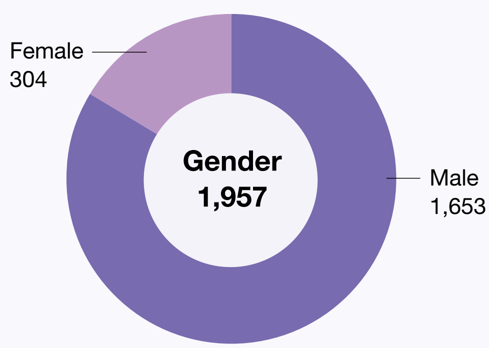
In 2013 RIKEN employed
3,433
Research and administrative staff

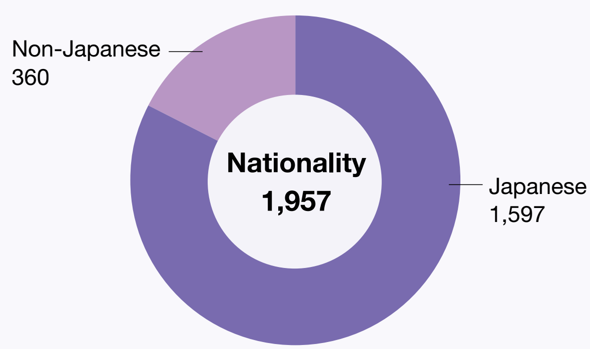
1,957
scientists work for RIKEN

International staff, visiting scientists and students at RIKEN

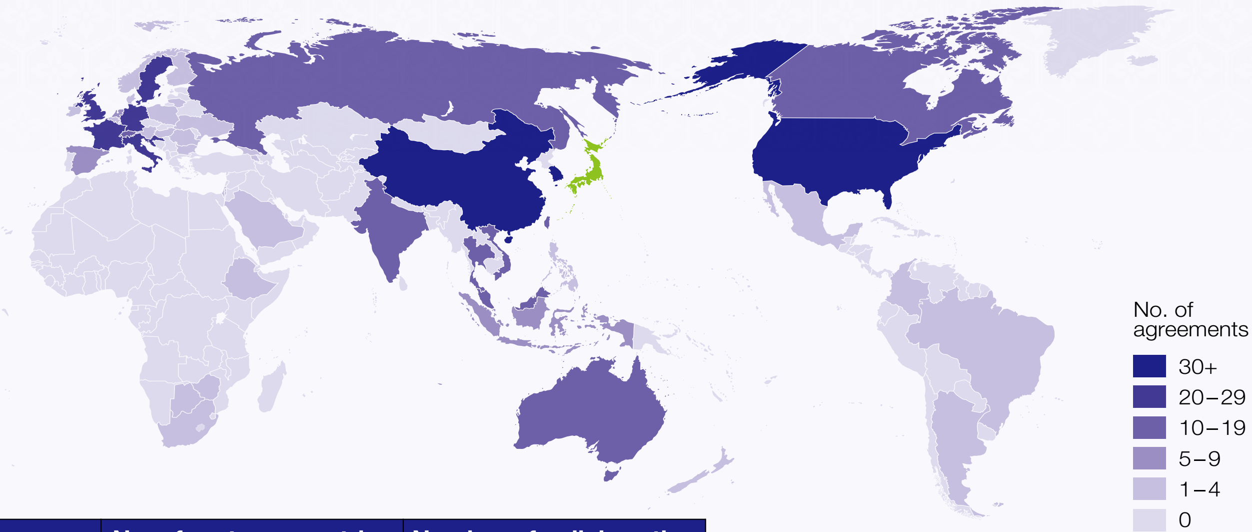


Diversity of RIKEN scientists





International collaborations



Region	No. of partner countries in each region	Number of collaboration agreements
North America	2	73
South America	4	12
Oceania	2	22
Asia	11	174
Middle East	2	3
Europe	23	179
Africa	4	6
Total	**48**	**469**

(as of March 2014)

ASIA	
China	Chinese Academy of Sciences (CAS)
	The Shanghai Branch of the Chinese Academy of Sciences (CAS Shanghai Branch)
	Shanghai Jiao Tong University (SJTU)
	Xi'an Jiaotong University (XJTU)
Korea	Korea Institute of Science and Technology (KIST)
	Korea Research Institute of Chemical Technology (KRICT)
	Korea Research Institute of Bioscience and Biotechnology (KRIBB)
	Seoul National University (SNU)
Taiwan	Academia Sinica (Taiwan)
Malaysia	University of Malaya (UM)
	Universiti Sains Malaysia (USM)
Singapore	Agency for Science, Technology and Research (A*STAR)
	Nanyang Technological University (NTU)
	National University of Singapore (NUS)
Indonesia	The Agency for the Assessment and Application of Technology (BPPT)
India	Department of Science and Technology (DST)
	Department of Biotechnology (DBT)
	Jawaharlal Nehru Centre for Advanced Scientic Research (JNCASR) & Indian Institute of Science (IISc)
	NCBS Consortium (National Center for Biological Sciences (NCBS), Institute of Stem Cell Biology (inSTEM) & Centre for Cellular and Molecular Platforms (C-CAMP))

NORTH AMERICA	
Canada	McGill University
SOUTH AMERICA	
Brazil	Amazonas State University (UEA)
OCEANIA	
Australia	Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO)
MIDDLE EAST	
Israel	Weizmann Institute of Science
EUROPE	
Sweden	Karolinska Institutet (KI)
UK	University of Liverpool (UoL)
Germany	Max Planck Society (MPG)
	Technische Universität München (TUM)
France	Institut Pasteur
	Centre National de la Recherche Scientifique (CNRS)
	Université de Strasbourg (Unistra)
Switzerland	Swiss Federal Institute of Technology Zurich (ETH Zurich)

(as of March 2014)

History of RIKEN

In 2013, researchers from RIKEN's Center for Developmental Biology began the world's first clinical trials of induced pluripotent stem (iPS) cells generated from adult cells. They will be used to treat macular degeneration, a leading cause of blindness in human beings. And in 2012, the element 113 was verified as having been produced at RIKEN's Nishina Center for Accelerator-Based Science.

These two examples show that RIKEN—Japan's flagship government-funded research agency, an independent administrative institution—is at the forefront of global research. Like a phoenix it has risen from the ashes of its near destruction after World War II.

A start in physical and chemical research

RIKEN or Rikagaku Kenkyūsho, the Institute of Physical and Chemical Research, was established in 1917 to lead Japanese industry from a dependence on mechanical manufacturing to a broader base in science. The dream of leading chemist Jokichi Takamine was realized by a committee of prominent business people led by Eiichi Shibusawa. They cobbled together a foundation of private contributions and government subsidies. It included a significant ten-year donation from Emperor Taisho.

Even so, the fledgling organization struggled for the first four years of its life. As its facilities were being built, the economy faltered and money began to dry up. It was the third director, Masatoshi Okochi, who secured RIKEN's future after taking over in 1921 by putting into practice the idea of industry founded on science. In the 1920s and 1930s, he set up a separate industrial conglomerate based on RIKEN technology that, at its peak, contained 63 companies and provided RIKEN with about 60 per cent of its income.

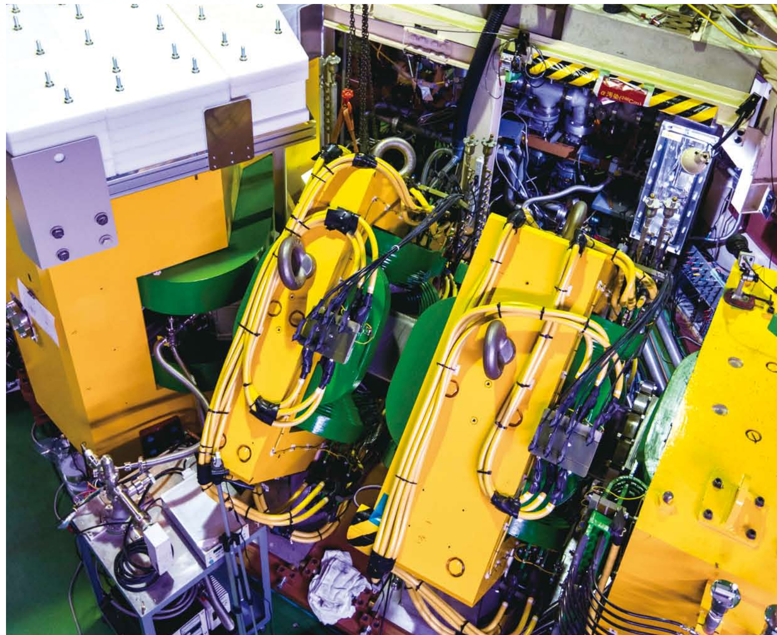
Impact of World War II

Meanwhile, RIKEN flourished scientifically. In physics, for instance, it produced results that eventually led to two Nobel Prizes. It also built and commissioned the world's second cyclotron. But in the lead-up to and during World War II, some of RIKEN's research and resources were co-opted by the Japanese military. This led to RIKEN facilities being specifically targeted by Allied bombers. After Japan's surrender, the organization was dismantled and its two cyclotrons were dumped into the deep waters of Tokyo Bay.

RIKEN avoided full destruction, however, and since the war its story has traced a path similar to its early history. In 1948, the remnants of RIKEN became a private



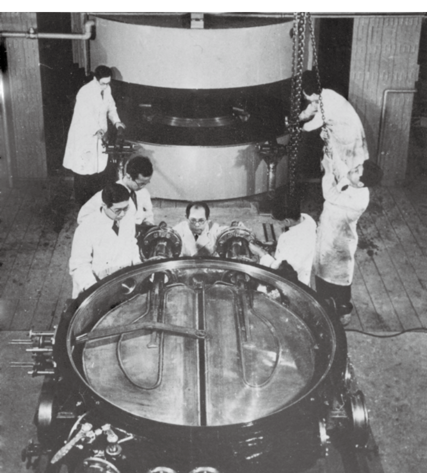

corporation called KAKEN that struggled for 10 years to survive on manufacturing and selling antibiotics and precision instruments, as well as developing processes for the production of liquid oxygen for the Japanese steel industry. Finally, in 1958, RIKEN was reconstituted as a public corporation owned by the Japanese government.

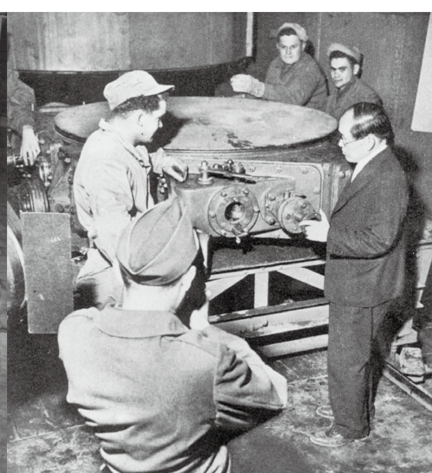


Growing to house key infrastructure

Since then, RIKEN has grown and diversified from its large campus at Wako, in northwest Tokyo, to six other sites around Japan, another in the UK and two more in the US. It employs about 3000 scientists and, with a budget of more than US$800 million, undertakes research over a broad range of natural sciences from particle physics to genomics, medicine and the workings of the brain.

RIKEN has overseen the development of, and become the custodian of, much of Japan's national scientific infrastructure, such as the world's most powerful, third generation synchrotron, SPring-8; one of the world's most powerful computers, the K computer; a significant BioResource Center which supplies model species worldwide; and an award-winning x-ray free-electron laser facility, SACLA.





PR and communication

RIKEN is sometimes said to be one of Japan's best kept secrets, but we are working hard to increase our visibility and to tell people how our high-quality research benefits society.

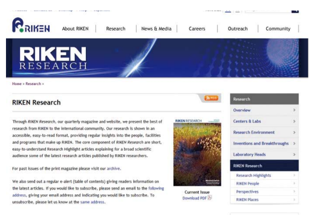
Of the many communication channels we use, our primary one and main public face is the RIKEN website, www.riken.jp/en. On it we provide the latest RIKEN news and events, along with information on our different laboratories and the work they are doing.

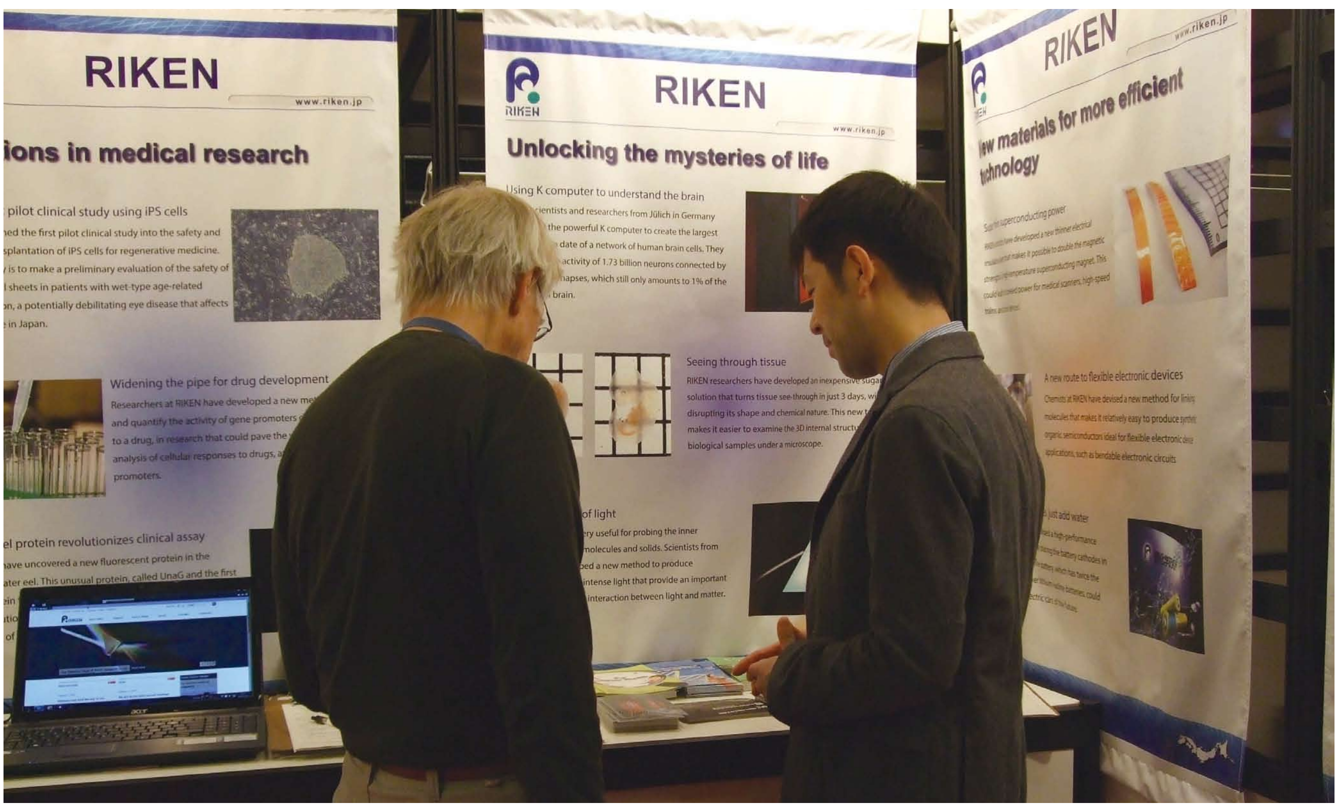
An important part of the site is the online version of our magazine *RIKEN Research*, replicating the printed publication that is distributed to partner organizations and libraries around the world.

We issue regular press releases in both Japanese and English, and we maintain a close relationship with journalists to ensure that they always have a direct channel to our researchers, helping them to come up with news that will attract their readers.

In addition, we actively engage the public through more interactive channels like Twitter and our video library on YouTube.

Finally we regularly open our campuses to the public—usually once each year—allowing local people to come to get a hands-on view of RIKEN's impressive research facilities. The public are able to take guided tours of some of our most interesting facilities, such as the K computer in Kobe and the Radioisotope Beam Factory in Wako.





The RIKEN booth in the Japanese pavilion at AAAS 2014

RIKEN directory

Japan

Wako

Center for Emergent Matter Science
Center for Advanced Photonics
Center for Sustainable Resource Science
Brain Science Institute
Nishina Center for Accelerator-Based Science
Advanced Center for Computing and Communication
Research Cluster for Innovation
Chief Scientist Laboratories
Associate Chief Scientist Laboratories
Distinguished Senior Scientist Laboratories
Initiative Research Units/Special Research Units
Research Groups
Global Research Cluster

2-1 Hirosawa, Wako,
Saitama 351-0198, Japan
Tel: +81-(0)48-462-1111

Sendai

Center for Advanced Photonics
519-1399 Aoba, Aramaki, Aoba-ku, Sendai,
Miyagi 980-0845, Japan
Tel: +81-(0)22-228-2111

Tsukuba

BioResource Center
3-1-1 Koyadai, Tsukuba,
Ibaraki 305-0074, Japan
Tel: +81-(0)29-836-9111

Yokohama

Center for Sustainable Resource Science
Center for Integrative Medical Sciences
Center for Life Science Technologies
1-7-22 Suehiro-cho, Tsurumi-ku, Yokohama,
Kanagawa 230-0045, Japan
Tel: +81-(0)45-503-9111

Nagoya

2271-130 Anagahora, Shimoshidami,
Moriyama-ku, Nagoya, Aichi 463-0003, Japan
Tel: +81-(0)52-736-5850

Kobe

Center for Developmental Biology
2-2-3 Minatojima-minamimachi, Chuo-ku,
Kobe, Hyogo 650-0047, Japan
Tel: +81-(0)78-306-0111

Center for Life Science Technologies
6-7-3 Minatojima-minamimachi, Chuo-ku,
Kobe, Hyogo 650-0047, Japan
Tel: +81-(0)78-304-7111

Advanced Institute for Computational Science
7-1-26 Minatojima-minamimachi, Chuo-ku,
Kobe, Hyogo 650-0047, Japan
Tel: +81-(0)78-940-5555

HPCI Program for Computational Life Sciences
7-1-26 Minatojima-minamimachi, Chuo-ku,
Kobe, Hyogo
650-0047, Japan
Tel: +81-(0)78-940-5835

Osaka

Quantitative Biology Center
OLABB, Osaka University, 6-2-3 Furuedai,
Suita, Osaka 565-0874, Japan
Tel: +81-(0)6-6155-0111

Harima

SPring-8 Center
1-1-1 Kouto, Sayo-cho, Sayo-gun,
Hyogo 679-5148, Japan
Tel: +81-(0)791-58-0808

Tokyo

Center of Research Network for Infectious Diseases
Jimbocho 101 Bldg. 8th fl., 1-101,
Kanda-Jimbocho, Chiyoda-ku,
Tokyo 101-0051, Japan
Tel: +81-(0)3-3518-2952

Tokyo Liaison Office
Fukoku Seimei Building,
23rd floor (Room 2311),
2-2-2 Uchisaiwaicho, Chiyoda-ku,
Tokyo 100-0011, Japan
Tel: +81-(0)3-3580-1981

Itabashi Branch
1-7-13 Kaga, Itabashi,
Tokyo 173-0003, Japan
Tel: +81-(0)3-3963-1611

Overseas

RIKEN Beijing Representative Office
1008, Beijing Fortune Building, No. 5,
Dong San Huan Bei Lu,
Chao Yang District, Beijing, 100004, China
Tel: +86-(0)10-6590-9192
Fax: +86-(0)10-6590-9897

RIKEN Singapore Representative Office
11 Biopolis Way, #07-01/02 Helios 138667,
Singapore
Tel: +65-6478-9940; Fax: +65-6478-9943

RIKEN BNL Research Center
Building 510A, Brookhaven National
Laboratory, Upton, New York 11973, USA
Tel: +1-631-344-8095; Fax: +1-631-344-8260

RIKEN Facility Office at RAL
UG17 R3, Rutherford Appleton Laboratory,
Harwell Science and Innovation Campus,
Didcot, Oxfordshire
OX11 0QX, UK
Tel: +44-1235-44-6802
Fax: +44-1235-44-6881

RIKEN–MIT Center for Neural Circuit Genetics
MIT 46-2303N, 77 Massachusetts Avenue,
Cambridge, Massachusetts 02139, USA
Tel: +1-617-324-0305
Fax: +1-617-324-0976, +1-617-452-2588

RIKEN–KRIBB Collaboration Research Center for Chemical Biology
685-1 Yangcheonri, Ochang, South Korea

RIKEN–USM Joint Laboratory for Bioprobe Discovery
11800 Universiti Sains Malaysia, Pulau Pinang,
Malaysia

RIKEN–XJTU Joint Research Center
28 West Xianning Road, Xi'an, China

RIKEN-SIOM Joint Research Laboratory
Shanghai Institute of Optics and Fine Mechanics
Chinese Academy of Sciences
Shanghai 201800, China

RIKEN-Tsinghua Research Groups
School of Sciences
Tsinghua University
Beijing 100084, China

Further information

For more detailed information about our locations, please visit: www.riken.jp/en/about/map

Addresses and centers current as of July, 2014 www.riken.jp

Since 1917

RIKEN 2014 - 037