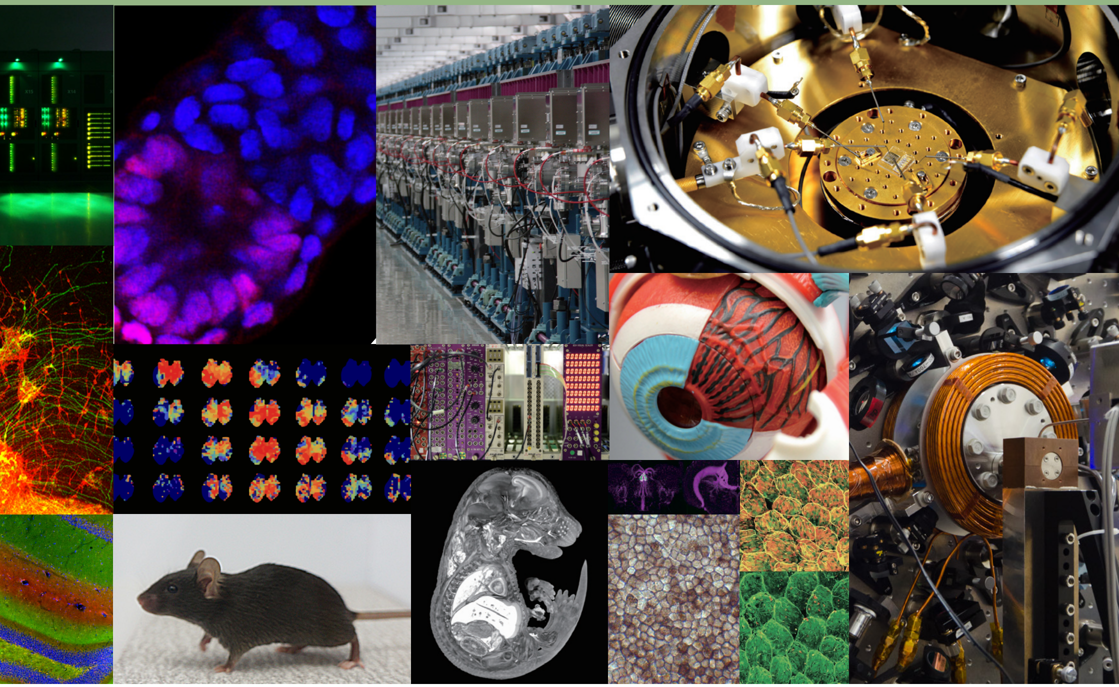
RIKEN

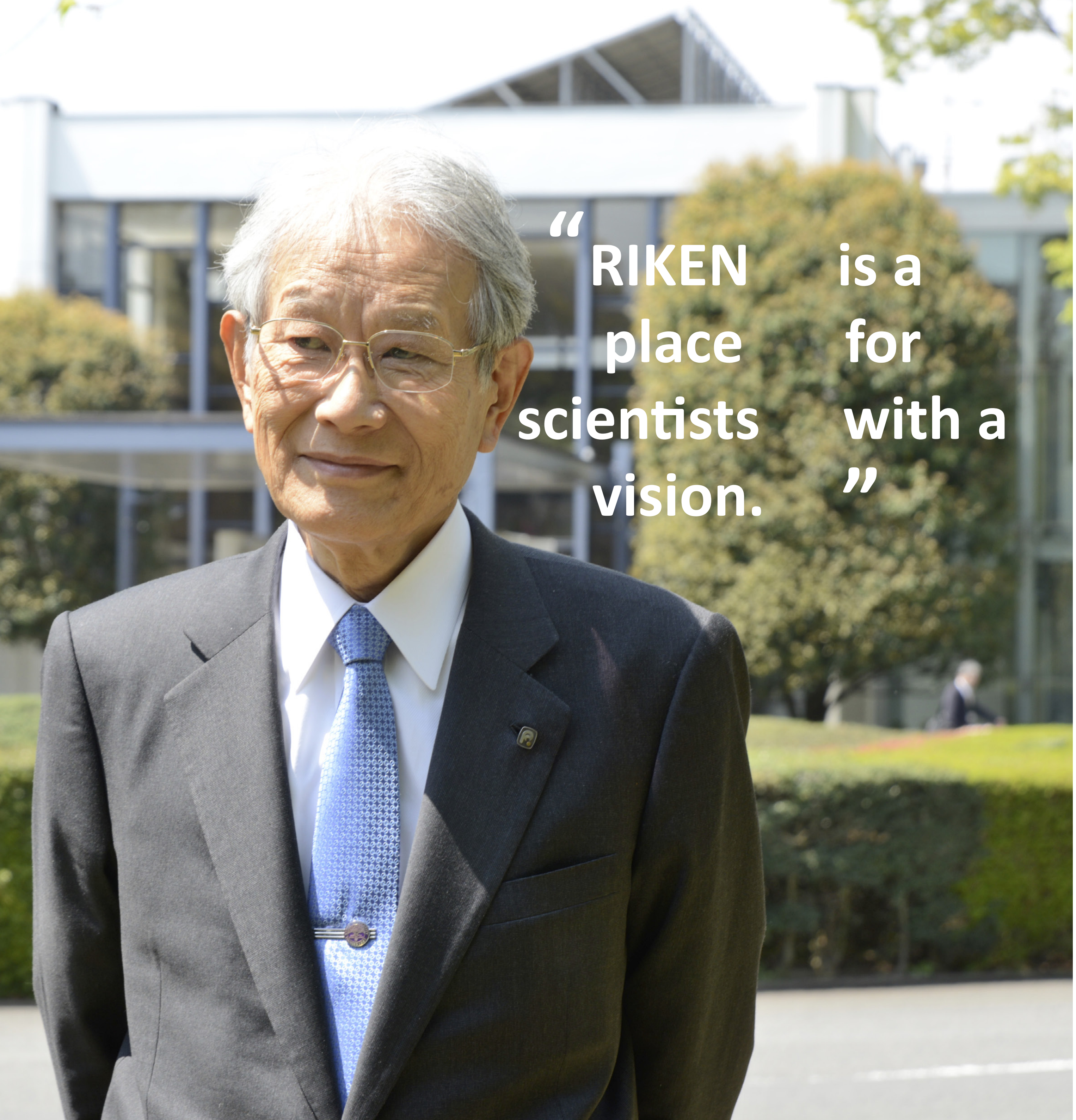
National Science Institute



AT A GLANCE

November 2015

RIKEN Since 1917



Message from the President

Though curiosity-driven basic research is a wonderful thing—and something that we strongly support at RIKEN—scientific research must also work to ensure the continued survival of the human race. The development of science and technology in the 20th century led to major improvements in our standards of living, but it has left us struggling with global issues such as population growth, resource depletion, and climate change.

Developing science and technology that can contribute to solving these complicated issues will require young, talented scientists with, above all, a vision of how the world could be made better a hundred years from now, and the will to work toward that vision. Scientists must pursue science, of course, but they must also pursue philosophy.

At RIKEN, we have wonderful facilities, we have a research environment that helps researchers to unleash their potential, and as a comprehensive research institute in the natural sciences, we have a system that stimulates interdisciplinary collaboration and encourages researchers to become pioneers in new fields of research. RIKEN is a place for enthusiastic scientists with visions of the future and we are actively nurturing researchers who will become leaders of the future.

Contents

For further information regarding the research presented in this publication or to arrange an interview with a researcher, please contact:

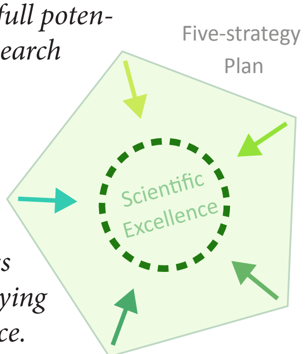
RIKEN Global Relations and Coordination Office
pr@riken.jp

Homepage: **www.riken.jp/en**
Facebook: **RIKEN.english**
Twitter: **riken_en**
Youtube: **rikenchannel**

Initiative for Scientific Excellence

To ensure that Japanese innovation promotes co-existence with nature, contributes to the progress of humanity, and helps sustain Japan as one of the world's leading economies, RIKEN will contribute to fulfilling our nation's science and technology strategies by realizing our full potential for scientific excellence as a comprehensive research institute.

*We will work with Japan's universities to enhance Japan's scientific prowess, serve as a science and technology hub for research institutions and industries around the world, and achieve world-class results grounded in high ethical standards by applying **the following five strategies** for scientific excellence.*



1 Pioneer a research MANAGEMENT MODEL for maximizing research and development results

We will strengthen RIKEN's headquarter functions to achieve optimal performance throughout the organization, integrate our currently divided personnel systems for permanent and fixed-term employees, introduce a new tenure-track system, and work to pioneer a new research management system that will serve as a model for all National Research and Development Institutes.

2 Lead the world in achieving NEW RESEARCH & DEVELOPMENT outcomes

We will respond to the needs of society with forward-looking research and development by deepening our basic research efforts and actively promoting interdisciplinary undertakings. With our pioneering research groups and state-of-the-art research infrastructure, we will attract outstanding researchers from around the world capable of generating results of the highest scientific excellence.

3 Become a HUB FOR SCIENCE & TECHNOLOGY innovation

We will strive for scientific excellence in close collaboration with Japan's universities, and serve as a science and technology hub for research institutions and industries around the world to achieve advances in innovation.

4 Serve as a focal point for GLOBAL BRAIN CIRCULATION

We will build a world-class research environment meeting the highest global standards to attract outstanding researchers from other countries and regions, thereby making Japan a focal point of global brain circulation.

5 Foster WORLD-CLASS LEADERS in scientific research

We will depart from strategies directed at achieving short-term results, and will design and implement a long-term, stable employment system offering attractive career paths for young researchers of superior ability. By tapping into the global exchange of personnel, we will foster the development of world-class leaders in scientific research.

"The RIKEN Initiative for Scientific Excellence is not a strategy aimed at benefiting RIKEN alone. Rather, it is an attempt to share and expand RIKEN's scientific knowledge and skills to universities, other research institutes, and industry, to forge collaborations that will advance Japan's scientific prowess as a nation. Further down the line, it is my hope that we can share Japan's scientific excellence with the world, including developing countries and regions, and thereby contribute to the welfare of humanity in general."

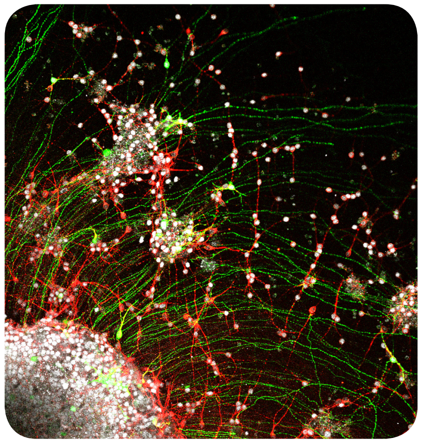
— President Hiroshi Matsumoto

Mysteries of Life
basic biology research

RIKEN carries out research in a broad range life sciences, from developmental biology and neuroscience to omics-based research and plant science, with an overarching goal of giving people better health and creating a better environment.

Organogenesis & cloning

RIKEN scientists are on the leading edge of work striving to grow human tissue in the laboratory. In early 2015, researchers from CDB succeeded in inducing human embryonic stem cells to self-organize into a three-dimensional structure similar to the cerebellum, while other researchers at CDB grew self-organizing retina cells from embryonic stem cells.



Migrating hESC-derived granual-cell neurons in the developing 3D cerebellar-like structure @ CDB

These first steps toward recreating neural structures in the laboratory are truly groundbreaking. Though it is not yet possible to grow *transplantable* 3D brain tissue in the laboratory, RIKEN is leading the way in this field that was considered science fiction just a few years ago, and which could ultimately create a world in which injured brain tissue can be replaced with tissue grown outside the body.

RIKEN's work extends to cloning as well. Using the same technique that created Dolly the sheep, in 2013, researchers from CDB discovered a way to produce healthy mouse clones that live a normal lifespan and can be sequentially cloned indefinitely. In experiments, the researchers were able to produce 581 clones of one original "donor" mouse, including 25 consecutive rounds of cloning.

Center names, abbreviations, and profiles can be seen from page 42.

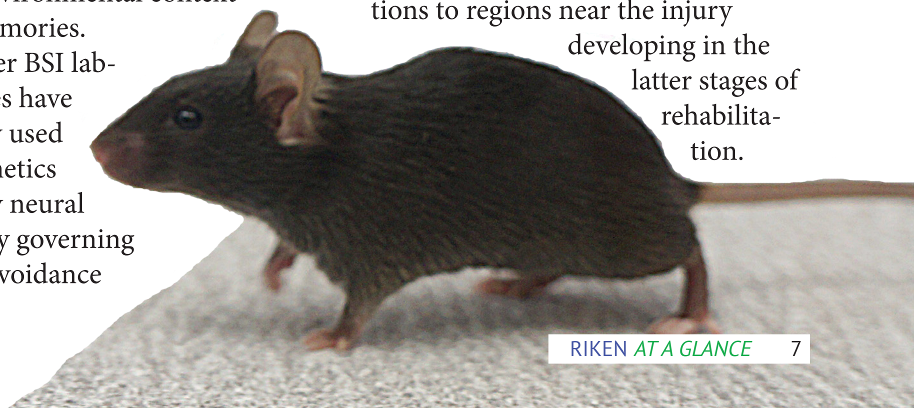
Optogenetics & neuroscience

Optogenetics is a powerful tool for studying neural circuitry and functional anatomic connections. By inserting light-gated ion channels from algae into specific neurons, scientists can excite or inhibit targeted circuitry with light.

In 2013, scientists from the RIKEN BSI-MIT collaboration used optogenetics in mice to transform good memories into bad ones, and vice versa, demonstrating for the first time that memories can be changed. In 2015, the collaboration again used optogenetics, this time showing that chronic stimulation of "happy" memories can reduce stress-induced depression in mice.

The RIKEN BSI-MIT collaboration has also used optogenetics to retrieve "lost" memories in amnesiac mice, and to identify neurons that code environmental context into memories.

Other BSI laboratories have recently used optogenetics to study neural circuitry governing threat avoidance in zebrafish, and fear-learning, the sense of touch, and even parenting behavior in mice.



Mapping biological systems

In 2000, RIKEN initiated a global research project called FANTOM, with the aim to map the transcriptomes of humans and mice. The project has helped us understand the function of DNA that is not coded into proteins. In a series of papers, the group laid out a gene-transcription map of the human body, showing how promoters and enhancers work together to regulate gene expression.

Most recently, in 2015, researchers from CLST published an overall map of how cells in the human body communicate by systematically analyzing the relationship between ligands and their receptors.

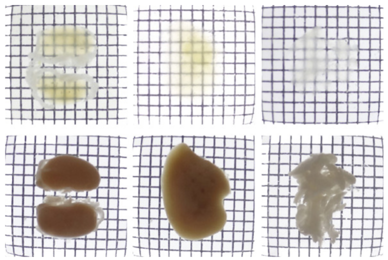
Researchers from CLST have also shown how rehabilitative training remaps motor systems after brain damage, with functional connections to regions near the injury developing in the latter stages of rehabilitation.

Fluorescence and transparency

Imaging biological systems is a fundamental aspect of research in the life sciences, and RIKEN is doing this both through the development of new fluorescent markers—which can indicate what genes are currently being expressed in different cells—and clearing agents, which allow us to see deep structures inside tissue by making the tissue transparent.

A team led by Atsushi Miyawaki at BSI has developed a new marker that glows green in the presence of bilirubin—an indicator of abnormal liver function when high. Most recently, the team has developed two optical clearing agents that allow scientists to look inside mammalian brains. The latest was instrumental in creating 3D images of amyloid-beta plaques in Alzheimer's diseased brains.

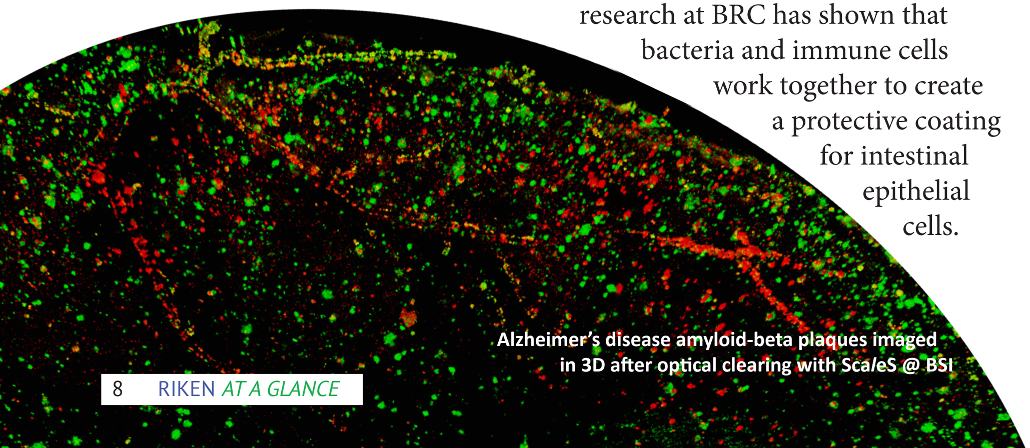
Research groups at two other RIKEN centers—CDB and QBiC—have also developed agents that make tissue invisible. The reagent created at QBiC in 2014 allows whole bodies to be imaged, as the solution elutes heme.



Transparent organs (upper panel) compared to those treated with saline (lower panel) @ QBiC

Gut bacteria & the immune system

Several studies carried out at RIKEN have focused on the role that gut bacteria play in maintaining a healthy immune system. In 2014, researchers at IMS showed how the diversity of gut microbiota and the health of the immune system have a two-way relationship. Other research at BRC has shown that bacteria and immune cells work together to create a protective coating for intestinal epithelial cells.



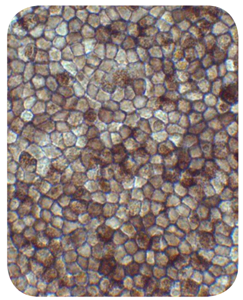
Alzheimer's disease amyloid-beta plaques imaged in 3D after optical clearing with ScaleS @ BSI

Innovations for a healthy society

RIKEN scientists are at the forefront of the ongoing revolution in regenerative medicine and are striving to understand and find therapies for a variety of diseases.

Stem cell and regenerative medicine

In 2013, CDB researchers initiated the world's first clinical study using induced pluripotent stem (iPS) cells in human patients, and in 2014, the leader of the project, Masayo Takahashi, performed the first transplant of iPS-derived laboratory grown tissue into a human patient. This pilot study is testing the safety of iPS cells as a treatment for age-related macular degeneration—a leading cause of vision loss in elderly people. To date, the treatment has had no ill effects.

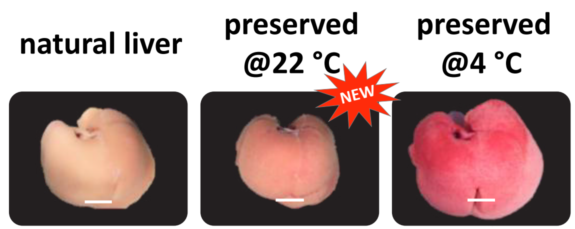


iPS cell-derived retinal pigment epithelium cells @ CDB

In other iPS-cell research, RIKEN scientists were able to create iPS cells by reprogramming killer T-cells that target a specific type of cancer cell. They then transformed the iPS cells into cancer killing T-cells. This may lead to novel ways to fight cancer.

Transplant technology

In another important area of medical research, scientists at CDB recently developed a new procedure for preserving organs for transplants. The procedure cools organs down to 22 °C and uses a perfusion system to supply oxygen to the tissue. The result is more successful transplants and longer lasting organs than what was previously possible using standard methods. Clinical tests with humans are expected in the future.



A new method for organ presevation was used to keep livers healthy for long periods of time before transplant @ CDB

Genetic diseases

In 2015, IMS researchers identified a gene that increases susceptibility to adolescent idiopathic scoliosis, a condition characterized by curvature of the spine.

Other research has targeted rare diseases such as Menkes disease, a genetic condition marked by impaired copper usage. The standard treatment today is to inject copper, but this therapy has limited efficiency. Using PET, CLST researchers discovered how the drug disulfiram can promote the accumulation of copper in the brain, while preventing it from entering the kidneys where it can become dangerous. Babies born with this illness rarely live beyond a few years, and achieving effective copper supplementation could offer hope for people with this deadly disease.

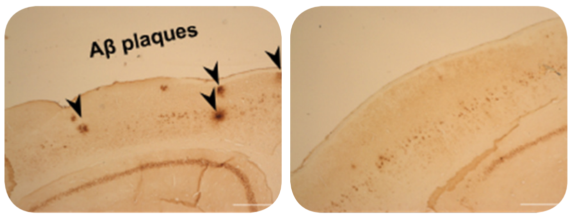
A rare human genetic disorder with severe consequences was recently found to be linked to a mutation in the human *NGLY1* gene. In a big step towards understanding the effects of this mutation, research by scientists at the RIKEN-Max Planck Joint Research Center implicated the enzyme ENGase as the factor responsible for deficient protein degradation that occurs in the absence of mouse Ngly1 gene expression.

Did you know ...

Umetaro Suzuki, one of RIKEN's earliest scientists, **discovered vitamin B1**, but was never given credit for the work. 100 years later, RIKEN is still on the leading edge of vitamin research. CLST scientists were able to "tag" vitamin B1 with a radioisotope, allowing it to be imaged throughout the body using PET.

Cognitive & developmental disorders

Alzheimer's disease, ADHD, and autism spectrum disorders are just a few brain-related disorders that RIKEN scientists are tackling. In 2014, following 12 years of work, scientists at BSI led by Takaomi Saido developed an innovative model mouse that closely resembles the human form of the Alzheimer's disease. This mouse model has led to promising investigations of new therapies that prevent or slow the onset of the disease.



The number of amyloid-beta plaques was greatly reduced when the mouse model for Alzheimer's disease lacked GnT-III (right panel) @ BSI

Using these mice, a group of researchers at the RIKEN-Max Planck Joint Research Center discovered a key protein called GnT-III whose elimination prevents the formation of amyloid-beta plaques, the hallmark of Alzheimer's disease.

Researchers at BSI are also focused on hyperactivity and social abnormalities, characteristics of ADHD and autism spectrum disorders. One group has identified a protein called IRBIT as a key player in preventing excessive dopamine production and limiting the development of these behaviors in mice.

Blood pressure

Studying how to control blood pressure is another area of research being pursued by RIKEN scientists because of its relationship with heart disease, a leading cause of death worldwide. Scientists at BSI recently discovered a novel mechanism for blood pressure control based on a protein called ERAP1, which helps the body rid itself of angiotensin II, a hormone associated with high blood pressure. In 2015, scientists from CSRS discovered a natural substance found in asparagus that inhibits angiotensin-converting enzyme (ACE). As inhibiting ACE prevents synthesis of angiotensin II, this substance could help reduce blood pressure.

Fertility

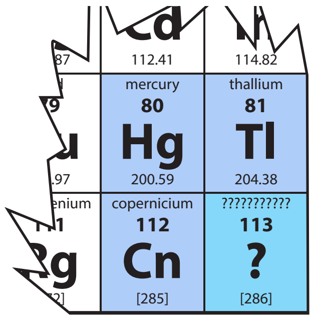
Researchers at CDB have used a novel imaging technique to pinpoint an event that leads to age-related chromosomal errors that usually result in a miscarriage or a genetic disease such as Down syndrome. They found that most errors occur when paired chromosomes separate too early during meiosis. Developing an artificial tie to suppress early chromosomal separation could help prevent these types of errors in the future.

Cancer

Cancer is one of the three largest causes of death worldwide, and RIKEN scientists are working hard to reduce the burden it puts on society. In 2013, a group from IMS was able to identify a compound that could be used as a new treatment to pevent relapse in AML—an acute type of blood cancer that begins in the blood-forming cells in bone marrow.

Understanding matter
basic research in physics and chemistry

RIKEN has a long tradition of excellence in physics and chemistry. In 1936, Yoshio Nishina—who is known as the father of Japanese nuclear physics—built Japan's first ever cyclotron, the first outside of the United States. After the war, Nishina continued to build cyclotrons, and today RIKEN has one of the world's premier nuclear physics facilities, the RIBF.



Element 113

In 2004, a group headed by Kosuke Morita of the RIKEN Nishina Center for Accelerator-Based Science, used the center's linear accelerator to successfully bombard zinc ions into a bismuth layer, creating a new element, number 113, which is currently known under the placeholder name of *ununtrium* (Un). When formally recognized by the International Union of Pure and Applied Chemistry and the International Union of Pure and Applied Physics, this will become the first element officially discovered in Asia. At that time, Dr. Morita and his team will be able to propose a name for the element.

Nuclear physics

Following in the footsteps of Dr. Nishina, scientists from the Nishina Center are working with partners around the world to better understand how the universe began and how it is composed at the nuclear level. Scientists at the Nishina Center continue to search for the "island of stability"—a realm where we can find longer-lived nuclei than those in the area currently explored.

Antimatter

RIKEN scientists are at the forefront of the quest to discover why the universe has an imbalance of matter over antimatter. In 2010, members of an international collaboration including RIKEN managed to trap antihydrogen atoms for 1,000 seconds. Recently, an international collaboration led by RIKEN used sophisticated equipment at CERN's Antiproton Decelerator in Europe to measure the magnetic moment of the proton, and in 2015, took the world's most precise measurement of the difference between a proton and an antiproton, finding them to be the same to within 69 parts per trillion.

Photonics

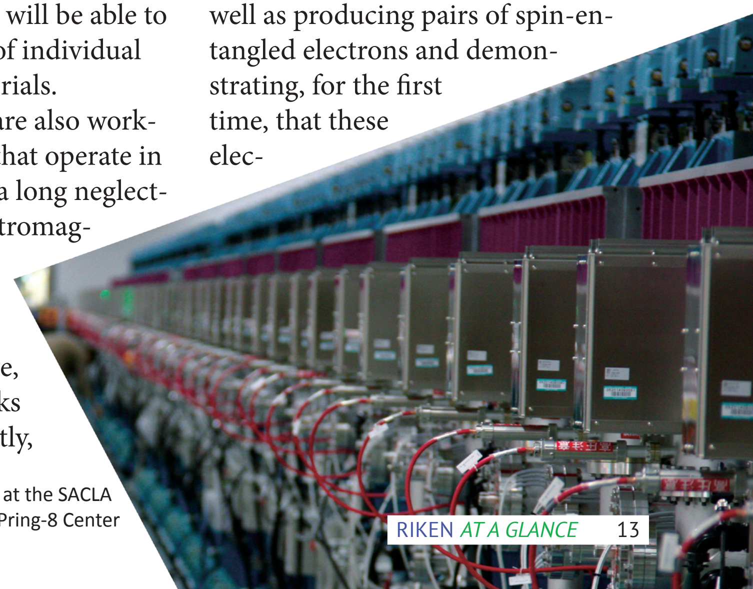
In photonics—the study of light—RIKEN scientists are working to see things that were previously invisible. One avenue of research is to develop lasers and other light devices with ever more powerful and rapid pulses, with the aim to develop attosecond lasers that will be able to look at the positions of individual electrons within materials.

Scientists at RAP are also working to develop lasers that operate in the terahertz range—a long neglected portion of the electromagnetic spectrum that will allow explosives and illicit drugs to be imaged within luggage, making security checks more rigorous. Recently, RIKEN scientists developed nonlinear optical materials that can convert terahertz light to higher frequency infrared light, which can be detected more efficiently.

Dissipationless electronics

Another major area of physical research for RIKEN is solid-state physics, in which scientists are engineering devices to take advantage of the special emergent properties of electrons. Spintronic devices and quantum computers are some of the potential future applications of this work.

CEMS researchers have recently demonstrated the existence of stable skyrmions—tiny magnetic vortices in materials that could be manipulated to create low-power memory devices—at room temperature, as well as producing pairs of spin-entangled electrons and demonstrating, for the first time, that these elec-



Undulators at the SACLA laser @ SPring-8 Center trons remain entangled even when they are separated from one another on a chip. This research could contribute to the creation of futuristic quantum networks operating using quantum teleportation.

New, better materials

In recent years, RIKEN scientists have been doing work with hydrogels—a type of polymer that is made up mostly of water but which, due to its chemical structure, adopts interesting properties. In 2015, a group at CEMS created a hydrogel that lengthens and contracts, like a muscle, in response to rises and falls in temperature. They were able to shape the gel in such a way that, when placed in a water tank, it could actually wade through the water.

Hydrogel @ CEMS

New catalysts

RIKEN scientists from CSRS recently made the news for "breaking benzene." Aromatic compounds are found widely in natural resources such as petroleum and biomass, and breaking the carbon-carbon bonds in these compounds plays an important role in the production of fuels and valuable chemicals from natural resources.

However, aromatic carbon-carbon bonds are very stable and difficult to break. In the chemical industry, the cleavage of these bonds requires the use of solid catalysts at high temperatures, usually giving rise to a mixture of products, and the mechanisms are still poorly understood. But in 2014, CSRS scientists showed a way to use a metallic complex, trinuclear titanium hydride, to accomplish the task of activating benzene by breaking the aromatic carbon-carbon bonds at relatively mild temperatures and in a highly selective way.

Did you know ...

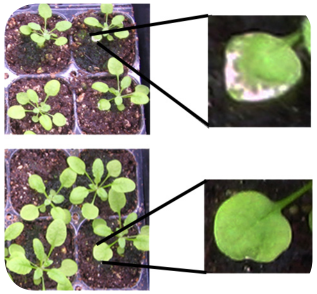
In 1937, RIKEN scientists thought they had discovered the muon, an important particle, but it turned out that a paper was published just five years before their discovery, by American physicists. The RIKEN measurements, however, were much closer to the actual mass of the muon.

Science to save humanity

Though RIKEN's work begins with basic research, we are aware of the need for our research to contribute to the survival of humanity in the face of a slew of problems—climate change, resource depletion, malnutrition for example—that can lead to conflicts and ultimately threaten our continued existence.

Fukushima aftermath

A number of RIKEN researchers are doing work aimed at mitigating the damage from the 2011 Great East Japan Earthquake, including salt damage to land and contamination from the meltdowns at the Fukushima Daiichi Nuclear Power Plant. At the Nishina Center, scientists are using the heavy ion beam to create new rice strains that could grow in soil with a high salt content.



Plants grown in contaminated soil treated with CsTolen A (bottom) remain healthy @ CSRS

In 2015, in collaboration with a private company, a group of astrophysicists used technology originally designed to detect cosmic rays to build a device for testing food for radioactive cesium—a major social need following the nuclear power plant accident. Also, scientists from CSRS identified a chemical compound that prevents plants from taking up cesium, thus potentially protecting them—and us—from its harmful effects.

Alternative materials and fuels

Reducing society's reliance on fossil fuels is an important step towards sustainability and RIKEN scientists are at the forefront researching promising alternatives.

One such effort is using cyanobacteria to produce bioplastics. CSRS scientists succeeded in achieving a threefold increase in the yield of PHB bioplastics by modifying cyanobacterial genes.

CSRS has also collaborated with JAMSTEC, a marine-science research institution, to generate 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 redox potential between the cold sea water and the hot hydrothermal fluid emitted by the vents.

Better electronic devices also promise to help humanity overcome the challenges we face. CEMS researchers recently improved polymer solar cells—a hot area of research due to both their strong potential and the significant challenges they pose—by using carefully designed materials and an "inverted" architecture, to boost the efficiency to 10 percent, bringing these cells close to the threshold of commercial viability.

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 CSRS scientists announced that they had devised a metal compound that can split nitrogen molecules and attach them to hydrogen under ambient temperature and pressure—a process required to produce ammonia, which is the basis for fertilizers and other industrial products.

Similarly, CSRS researchers collaborated with colleagues at McGill University in Canada to develop a catalyst that uses iron rather than rare and more polluting heavy metals to promote the hydrogenation chemical process used in may industrial applications.

Fighting droughts and pests

RIKEN is also focusing on agriculture and hopes to develop plants that are productive in poor water and nutrient conditions.

In efforts to fight pests, scientists from the RIKEN Innovation Center have developed 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.

In 2015, CSRS researchers found a way to cultivate cyanobacteria in seawater by adding a mixture of nitrogen and phosphorus and buffering the pH. This could allow for the development of more environmentally friendly biorefineries.

Plant science

Though much of RIKEN's work in biology focuses on animals, plants are another major focus, with a major goal of ensuring the survival of humanity. RIKEN has long been involved in international efforts to understand *Arabidopsis*—a model plant—and we rank among the top research institutes in the world in this area. In 2014, the ISI Web of Knowledge ranked RIKEN ***number three in the world*** in terms of citations per paper in the category of plant and animal science.

A group at CSRS has shown that brassinosteroids, a class of plant steroid hormones, play an important role in promoting plant growth as well as a host of developmental processes including cell elongation and division, development of the xylem—which is used for water and nutrient transport— and adaptation to differing light conditions.

Breeding better plants

At the Nishina Center, researchers are developing new plant varieties using heavy-ion breeding. This technique involves using heavy-ion beams to induce mutations. The group is focusing on creating new strains of sakura and other decorative plants, but is also dedicated to developing a strain of rice that is highly resistant to salt, and a fast-growing variety of the edible seaweed wakame.

At CSRS, researchers have recently discovered how vitamin C is transported into chloroplasts. As vitamin C is known to alleviate stress caused by excessive sunlight, this may lead to the development of crop plants with higher tolerances to environmental stress and reduce the damage to farmland in regions with strong light.

Arabidopsis **plant @ BRC**

Biofuel

In 2015, CSRS scientists devised a new strategy for selectively delivering genes into the mitochondria of plant cells, opening up a path for creating a new field of "mitochondria engineering." This technology could enable the creation of mitochondria-based plant cell factories, which can be used for producing bio-polymers and biofuels.

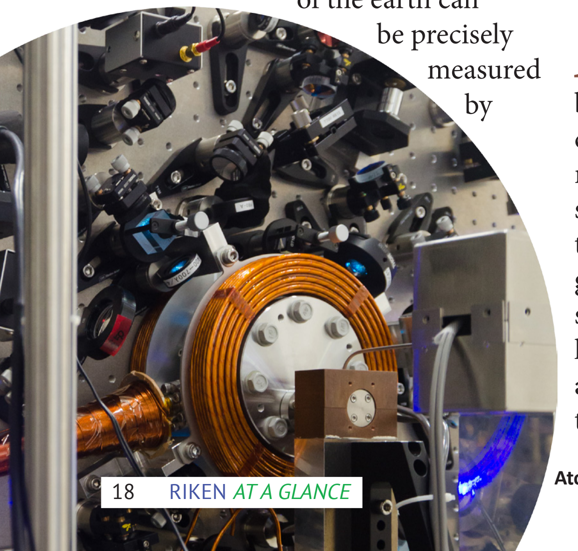
Extreme engineering

While making discoveries that will contribute to the knowledge and welfare of humanity is the ultimate goal of science, this also requires the development of instruments to make these discoveries possible. While RIKEN has never engaged in building bridges or large airliners, we have always been at the forefront of engineering, designing and building scientific instruments that go beyond the now into the unknown.

An atomic clock

Today, RIKEN's engineering feats continue. A team from RAP has built a pair of optical lattice clocks that can keep time with incredible precision. While a typical quartz watch can vary by about 15 seconds every month, these clocks will only go out of sync by a second in around 16 billion years—more than the universe has existed so far. Using it, scientists plan to open the era of "relativistic geodesy," where the shape of the earth can be precisely measured by clocks going faster or slower following Einstein's theory of relativity.

> *Did you know ...*
>
> Early in RIKEN's history, Yoshio Nishina, the namesake of the Nishina Center, developed the first cyclotron in Japan—only the second in the world. His work helped propel Japan to a leadership position in nuclear physics.



Atomic Clock @ RAP

Robots

As part of a project that uses our understanding of the human brain to create new technologies that contribute to vehicle operation and rehabilitation for stroke victims, BSI scientists have developed a robot that learns to walk using a programmed desire to keep its motion sensors from moving abruptly. Unlike other walking robots, it walks at a very high efficiency, with a gait that approaches that of people.

Looking at the very small

The SACLA x-ray free electron laser in Harima allows us to look at the world on the smallest scale. Despite being just 700 meters in length it produces laser beams with a wavelength under 1 angstrom, the shortest in the world. These pulses are being used to see how bonds between atoms are formed to create molecules, and thus helping to answer fundamental questions about how matter is put together.

Even smaller-scale facilities can contribute. Using a tabletop light source, scientists from RAP led by Katsumi Midorikawa achieved a peak power of 2.6 gigawatts, emitting attosecond pulses that will be able to look at rapid processes such as the forming and breaking of molecular bonds.

Supercomputing

RIKEN made a big mark in 2011 when the K computer, developed in partnership with Fujitsu, took top place in the world's supercomputer rankings, holding the spot for a year. The K computer is now performing some of the world's most complex simulations, and RIKEN has been chosen to develop Japan's next generation supercomputer. The knowledge gained so far will be put to good use in areas such as drug development and material analysis.

AICS scientists have used the K computer to conduct the largest simulation to date of global weather. An enormous simulation—running 10,240 variations of a model of the global atmosphere divided into 112-km sectors—generated a model that closely fit real data between November 1 and November 8, 2011.

K computer @ AICS

The Shoubu computer, developed by ACCC in collaboration with Japanese venture companies, has made a mark of a different kind, being declared in 2015 to be the world's greenest supercomputer in the Green 500 ranking. It employs a unique architecture, with the components of the computer immersed in liquid to keep cool.

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. Our breakthroughs translate into much more than journal papers, however. We also actively encourage our researchers to patent their discoveries and protect our intellectual property portfolio to ensure that industry can use it to improve people's lives. Some of our recently licensed technologies include a high-tech blood pressure monitor, new varieties of Japanese cherry blossom trees, and a safe and environmentally friendly line of pesticides.

Safe and environmentally friendly pesticides developed @ RInC

Plants developed using heavy ion beams to generate advantageous mutations @ RIBF

Nishina Homare sake is made with yeast that was modified using the RIBF

In 2014 RIKEN held 1,333 patents

652 in Japan

681 ouside Japan

594 licenses were issued

RIKEN filed **348** new patents in 2014

RIKEN earned 134 million yen* from license contracts in 2014

*about US $1.2 million

RIKEN researchers published 2461 papers in 2014

By citation based on all papers published worldwide in 2013

24% ranked in the top 10%

4% ranked in the top 1%

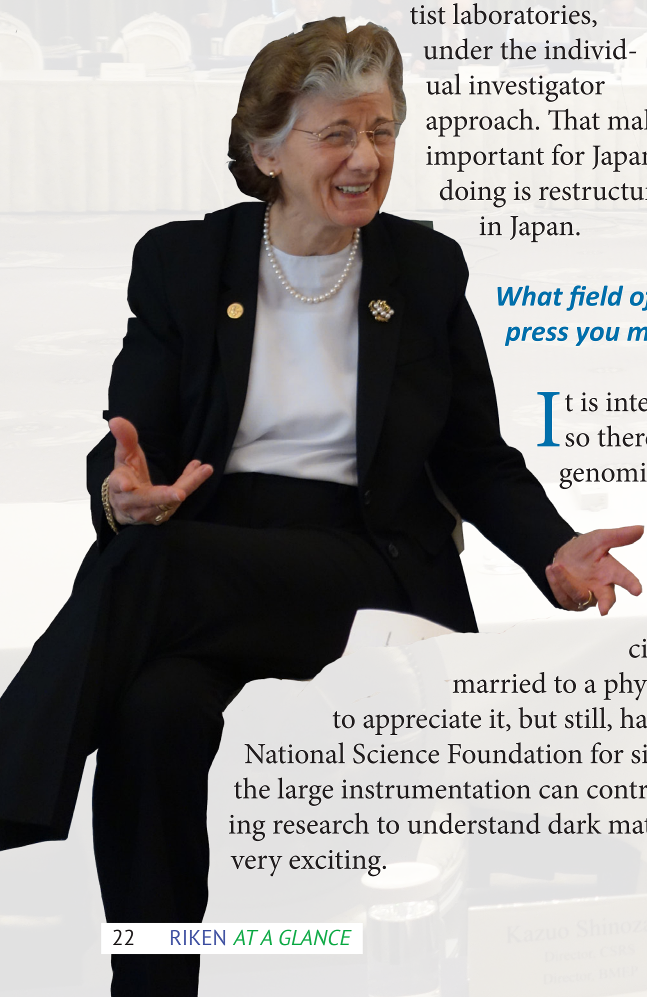
Source: Thomson Reuters Web of Science/Science Citation Index Expanded, May 8, 2015

Interview with Rita Colwell

Rita Colwell has been a member of the RIKEN Advisory Council since 2009 and the Chair since 2011, and is a former director of the National Science Foundation in the USA. We sat down with her in 2014 to discuss her thoughts about RIKEN.

What do you think makes RIKEN special?

RIKEN is a very unique organization. It's a place where excellent research gets done, and it's also for Japan a new type of operation, because it fosters the individual investigator and makes it possible for the younger scientist to be creative. As I noted in our report, some of the major discoveries at RIKEN have come from the Chief Scientist laboratories, under the individual investigator approach. That makes RIKEN very unique and important for Japan, because in a sense what it is doing is restructuring the way of doing research in Japan.



What field of research does RIKEN impress you most in?

It is interesting. I'm a life scientist, and so therefore what they are doing in genomics is very exciting, as well as in developmental biology. But I'm also fascinated by the K computer, SPring-8, the photonics work. It's really exciting. That may be because I'm married to a physicist, making it easier for me to appreciate it, but still, having been the director of the National Science Foundation for six years, and having seen how the large instrumentation can contribute significantly to furthering research to understand dark matter and all of the rest of it, it's very exciting.

RIKEN is known as a "paradise for scientists" in Japan. Do you think that is accurate?

RIKEN is, for Japan, the foremost place for research freedom. It's the closest to the independent investigator that you would find in the United States or the UK. As a young scientist I had complete freedom to write proposals to get funding and do research. I think the organization of laboratories in Japan has typically been a pyramid structure and not terribly tolerant of the ability of the scientist to be very independent. RIKEN has the greatest amount of independence, and that's probably why the young scientist thinks it's a place that he or she would like to be doing research.

How do you see RIKEN compared to other institutes around the world?

Like the Max Planck Society in Germany and the organization of national laboratories in the United States, it is a government research institution but with the ability to be independent and to carry out research. It's targeted research, but it's fundamental research, and the discoveries are really phenomenal.

What are some of RIKEN's discoveries that stand out for you?

Right now, I'm fascinated by the work on macular degeneration, I suppose because I'm reaching that age! But here is a terrific example of basic research being translated very quickly into a human health program of great significance.

What is RIKEN's greatest strength, and what challenges does it face?

I think the greatest strength is the amount of independence it provides its investigators. I can't emphasize that too much. Also, it nurtures fundamental science, and that's really terrific. It's also learning to do translational science. A challenge for RIKEN is that it is difficult to take advantage of its discoveries under the present framework, since it cannot launch companies. It would be nice to be able to do that, as many universities in the US and the UK and Europe can. It need not be linked in any way except maybe royalties or licenses, which would be enough of a tie and an income to build an endowment.

A welcoming environment

In addition to our state-of-the-art research facilities and open research environment, we aim to provide a comfortable and congenial environment for researchers and their families from around the world. A wide range of programs, services, and welfare benefits are available to all RIKEN employees, regardless of gender or nationality.

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 the major RIKEN campuses to provide information and support to help researchers deal with healthcare, housing, childcare and schooling, and the practical issues of daily life.

Housing

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

Events

The Mutual Benefit Society organizes events on the different campuses and provides funding for club activities 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 preschool aged children at the Wako, Yokohama and Kobe campuses.

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/

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.

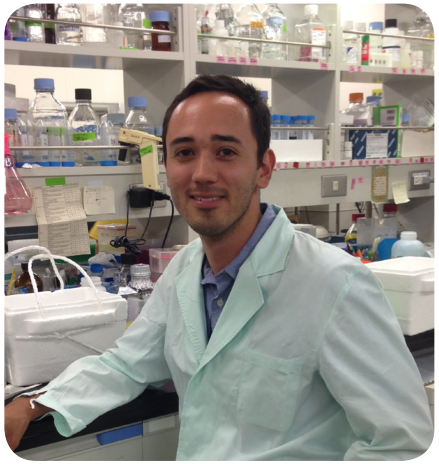
Special Postdoctoral Researchers Program

In the Special Postdoctoral Researchers (SPDR) program, young and creative scientists are given the opportunity to be involved in autonomous and independent research under the direction of their host laboratory's primary investigator. The program helps promising young scientists to establish global 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 yen (about US $8,000) allocated to the host laboratory.

The program is open to researchers in physics, chemistry, biology, medical science or engineering who have a doctoral degree and fewer than five years of postdoctoral experience. This is one of RIKEN's initiatives aimed at opening our facilities and resources to the world and creating a stimulating research environment that places our organization at the forefront of global science and technology.

"Doing research in RIKEN has given me a unique opportunity to work in a multidisciplinary environment with access to numerous resources unparalleled in many research centers in the world," says **Juan G. Betancur**, from Colombia, who is doing his postdoctoral research in the Laboratory for Developmental Genetics. "In addition, administrative and personal support is available whenever necessary, which helps me to focus on my research. I am currently using my own expertise in RNA biology, along with the strength of my current laboratory in mouse genetics and epigenetics, to understand the role of RNAs in the recruitment and function of epigenetic modifying factors."

Qualified candidates of all nationalities are welcome to apply.



International Program Associates Program

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.

As of October 2015, we had IPAs from 51 universities in Asia and Europe studying at RIKEN. They included students from Peking University in China, Seoul University in South Korea, USM in Malaysia, Liverpool University in the United Kingdom, and ETH Zurich in Switzerland.

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

"Joining RIKEN as an IPA has been a golden opportunity to enhance my skills and broaden my knowledge," says **Kruthi Suvarna** from India. "Thanks to the excellent work environment, advanced technology and support from the administration, I am able to work without stress.

"RIKEN also provides an excellent platform for presenting our ideas, including through various events that bring together scientists from different fields and multidisciplinary areas. The atmosphere stimulates creativity and allows the mixing of ideas. It has provided me the opportunity to use a skillfully developed chemical library against carcinoma-associated fibroblasts."

Schools/visiting scholars

In addition to the Special Postdoctoral Researcher and International Program Associates programs for young researchers, RIKEN operates a number of summer schools that give junior 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 one-week lecture course given by distinguished international scientists.

Nishina School

The Nishina School offers select students from Peking University, Seoul National University, and several Japanese universities, the opportunity to acquire hands-on experience in theoretical and experimental nuclear physics in a two-week summer school at the Nishina Center.

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 cutting-edge research in immunology and genomic medicine. It takes place over one week at the IMS facility in Yokohama and includes presentations from internationally distinguished scientists and each participant.

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.

BSI summer
www.brain.riken.jp/en/summer

IMS summer
www.ims.riken.jp/english/jobs/summer_program.php

Cheiron
www.spring8.or.jp/en/students#cheiron

Work force

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

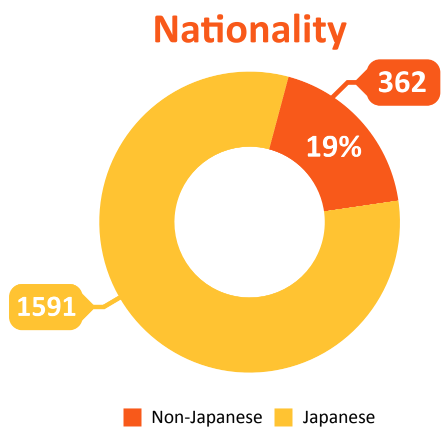
RIKEN employed 3,462 individuals in 2014, a figure that has remained relatively constant over recent years. Nevertheless, the number of international researchers has risen significantly in the past ten years, and now more than 18.5 percent of RIKEN's nearly 2,000 researchers come from outside Japan. Most are from nearby countries, including China and Korea, but a significant number have come from Europe, North America, and other countries in the Asia-Pacific.

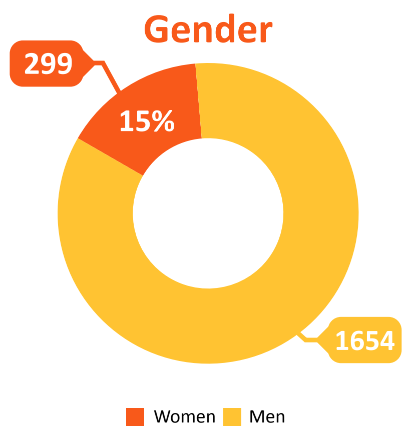
Through a focus on international recruitment, RIKEN has become a leader among Japanese research organizations in employing non-Japanese staff. We aim to increase the proportion of foreign research staff to 20 percent by 2018.

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.

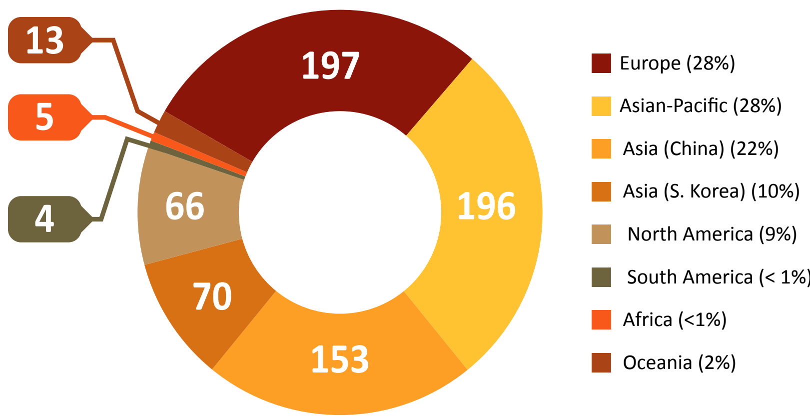
DEMOGRAPHICS

Diversity of RIKEN Scientists





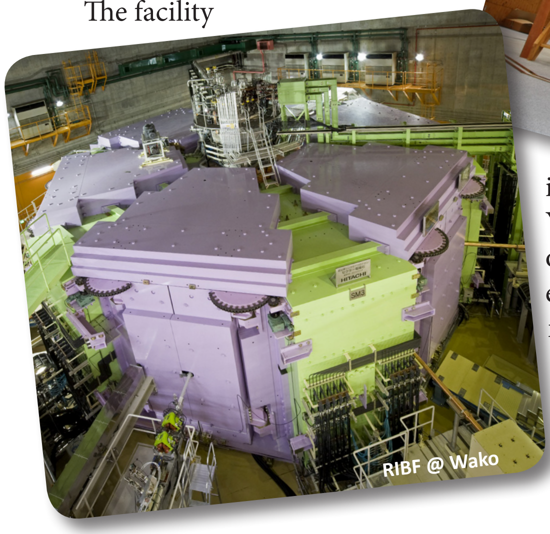
International Faculty & Staff



Facilities

Radioactive Isotope Beam Factory

The Radioactive Isotope Beam Factory (RIBF) at RNC 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.


RIBF @ Wako

Life Science Technology Platform

RIKEN has a rich set of advanced facilities used for research in medicine and other areas of life sciences. The NMR facility at CLST 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. In addition to medicine, these tools are being used to promote technological innovation.


NMR machine @ Yokohama

The Genome Network Analysis Service, also in Yokohama, offers gene expression analysis and genomic sequencing using high-throughput next-generation sequencers. Additionally, 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 a human resource development program for analyzing the dynamics of various molecules in the body.


K computer @ Kobe

K computer

The K computer located at AICS in Kobe is a national project 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 petaflops. 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. RIKEN is currently engaged in the development of a new post K supercomputer.

SPring-8 and SACLA

The RIKEN SPring-8 Center in Harima is a unique facility, the only research entity in the world offering both an x-ray free electron laser (SACLA) and a synchrotron radiation (SPring-8), at the same location. These two powerful tools are offered to researchers from both academia and industry, in Japan and from around the world, to conduct advanced research in materials science, spectroscopic analysis, earth and planetary science, life science, environmental science and industrial applications. SACLA, which 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, is an ideal instrument for observing extremely fast phenomena and small molecular structures, and has become a powerful tool for protein analysis.

BioResource Center

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.

Advanced Center for Computing and Communication

ACCC 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 services such as email, data storage and research databases as well as providing technical and R&D support to the supercomputer and bioinformatics programs.

Crossing boundaries

What makes RIKEN a really unique place is the way that scientists are encouraged to interact beyond disciplinary boundaries and to pioneer new fields.

Chief Scientist, Associate Chief Scientist, and Distinguished Senior Scientist laboratories

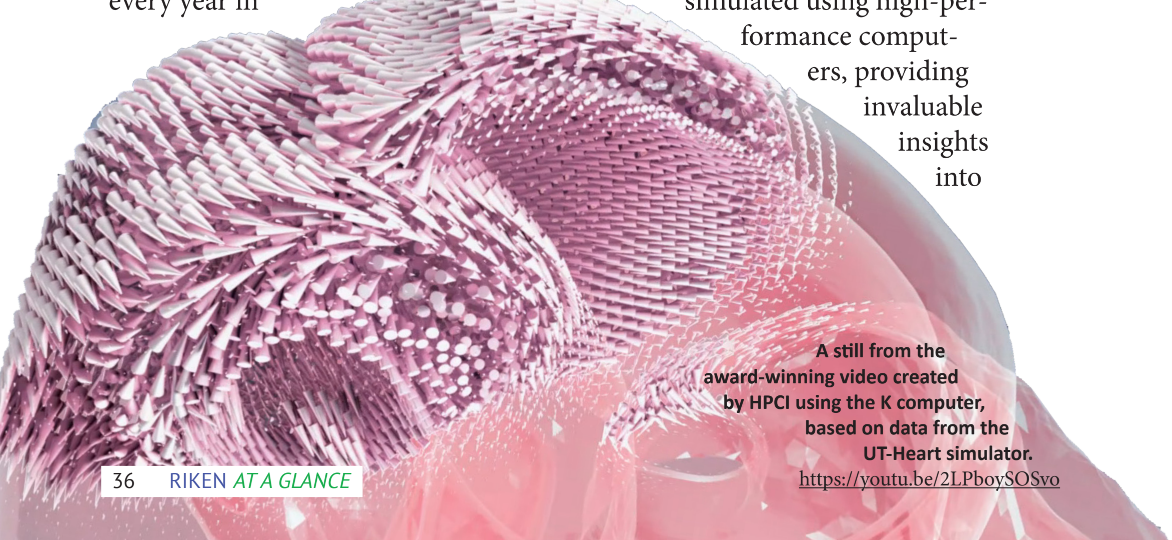
Chief Scientists, Associate Chief Scientists, and Distinguished Senior Scientists run independent laboratories and serve to coordinate research among the different research centers and scientific disciplines. Chief Scientists play a key role in RIKEN by serving as members of the RIKEN Science Council, which provides advice to the President on a wide range of matters.

Several strategic research centers have been deliberately organized with a multidisciplinary mission. The CSRS brings together chemists and biologists to collaborate on creating a more sustainable society, working together on projects to make better use of carbon dioxide, improve production efficiency of fertilizers based on nitrogen, and make efficient recovery and use of metals. At CEMS, specialists in physics, chemistry, and electronics are collaborating to create a new generation of highly energy efficient devices. And in the Interdisciplinary Theoretical Science (iTHES) Research Group, scientists from physics, chemistry, and life sciences are working together to discover new theoretical principles that apply to all branches of science.

Based on this structure, a number of events are held every year in which scientists from different fields, nationalities, and positions can come together to share their results and discuss how they can collaborate to help answer the scientific questions and social needs in line with RIKEN's mission.

High-performance computing

The 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, providing 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.



A still from the award-winning video created by HPCI using the K computer, based on data from the UT-Heart simulator.
https://youtu.be/2LPboySOSvo

Working 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 industry work together.

As the name suggests, the program involves a handing on of knowledge from one partner to another. That process is managed by a dedicated group, the RIKEN Innovation Center (RInC), whose job is to support the transfer of RIKEN's scientific achievements into commercial products through partnerships with private companies.

The Baton Zone includes the Integrated Collaborative Research Program with Industry, under which joint research teams headed by company personnel are

Did you know ...

The popular sports drink VAAM was developed by RIKEN Special Chief Scientist Takashi Abe, and was inspired by his studies of hornet venom at RIKEN. He discovered that a unique combination of amino acids in hornet larvae saliva allow them to fly 80 km a day, non-stop. The mixture works similarly in humans, and is the basis for the longer endurances afforded by drinking VAAM.

established for a limited time. But there are many other ways in which industry can become involved with RIKEN, including licensing its patents. In 2014, RIKEN held 652 domestic and 681 patents outside Japan for technologies ranging from physics to medicine.

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.

RIKEN VENTURE certification mark

Among these companies are Healios, which is working in the field of regenerative medicine using iPS cells, and NanoMembrane Technologies, which is conducting research and development on fuel cell component and membrane products. In 2015, Healios gained a listing on the Tokyo Stock Exchange's Mothers market.

Technology transfer

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

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

CIP includes two research programs for industry and society: the Drug Discovery program and the Preventive Medicine and Diagnosis program, which contribute to health research. These work in collaboration with the RInC, which administers RIKEN's collaborations with industry.

In addition to a Business Development Office, RInC operates several joint laboratories—such as the Ultra-Sensitive Biomolecule Detection Laboratory in conjunction with Olympus Corporation. 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.

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 preclinical and clinical phases of drug development.

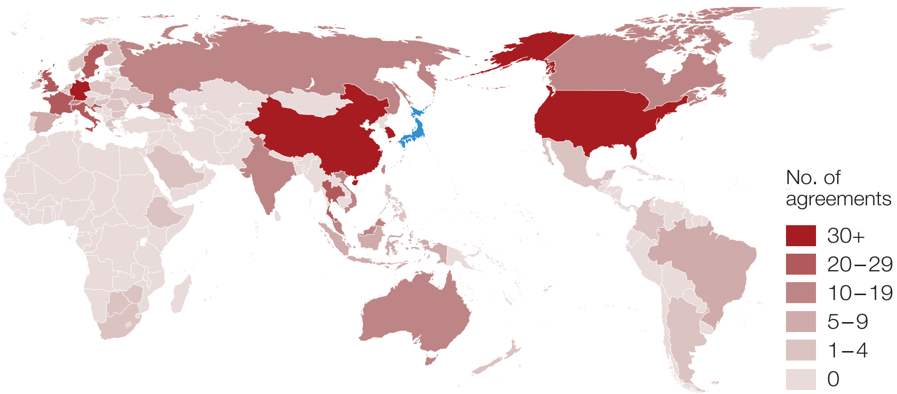
Preventive medicine

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 diagnostic kits.

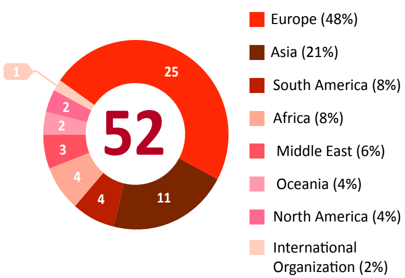
The Program interfaces between the scientific advances made at RIKEN and colleagues in medical institutions, companies and research organizations, ensuring that scientific breakthroughs are effectively translated into clinical practice.

International research partners

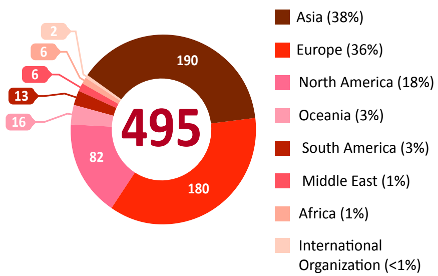
As RIKEN continues to grow, so does its network of collaborators at research institutions around the world. RIKEN actively supports research collaborations and the exchange of researchers, students and staff with universities and institutions all across the globe. The map below outlines the distribution of these reciprocal research arrangements, including the major institutions and universities that have a General Collaborative Agreement or Memorandum of Understanding (MoU) with RIKEN.



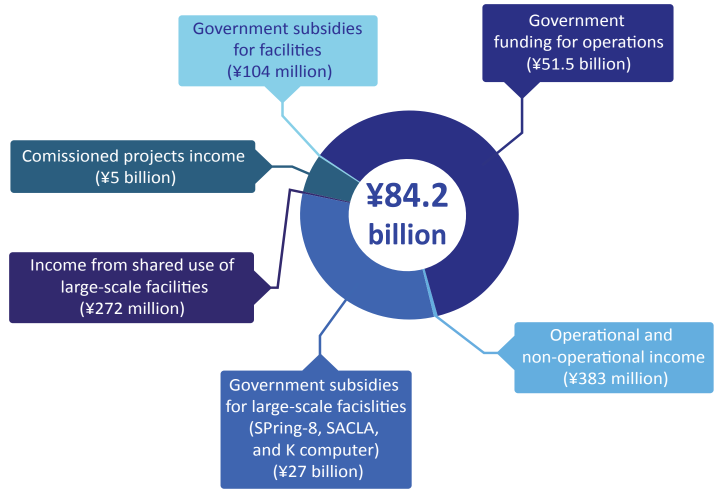
Number of Partner Countries



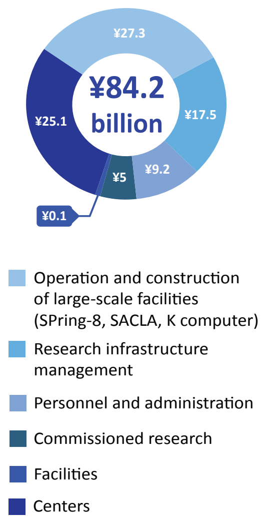
Number of Collaboration Agreements



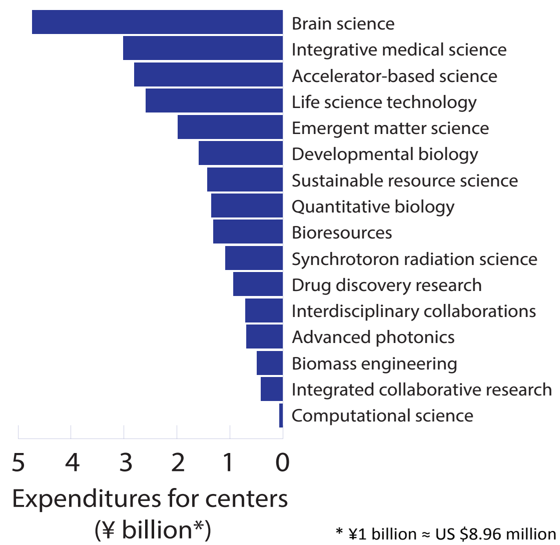
2015 Revenue



2015 Expenditures



Breakdown by Center



* ¥1 billion ≈ US $8.96 million

RIKEN centers

Center for Developmental Biology (CDB) pp. 6, 8, 9, 11

Research at CDB focuses on gaining insights into how the complex animal body develops from a fertilized egg—a single cell—and applying that knowledge to better understand the pathogenesis of a variety of human diseases, and to contribute to the advancement of medicine such as stem-cell based regenerative medicine. Since its establishment, CDB has become a leading institute with a strong record in 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 organogenesis and the use of quantitative approaches.

Center for Life Science Technologies (CLST) pp. 7, 10, 32

Next-generation life sciences and its applications are key to a healthy future for the world's population. Research at CLST focuses on designing molecular structures at the atomic level, manipulating molecular function 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.

Quantitative Biology Center (QBiC) p. 8

QBiC's aim is to achieve "whole cell modeling", which would give scientists an unprecedented understanding of dynamic living systems. In cells, molecules communicate 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 predictive diagnostics.

Brain Science Institute (BSI) pp. 7, 8, 10, 11, 18, 28, 29, 39

BSI 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.

Center for Sustainable Resource Science (CSRS) pp. 11, 14-17, 35

CSRS contributes to the development of sustainable production of energy, chemicals, and biomaterials by conducting integrated biological and chemical studies. Interdisciplinary projects are underway in four key areas of research. **(1)** ***Carbon utilization*** – investigating ways to enhance photosynthesis in plants and developing catalysts for efficient use of carbon dioxide. **(2)** ***Nitrogen utilization*** – developing new methods for resilient agriculture and efficient production of fertilizer from nitrogen. **(3)** ***Metallic element utilization*** – using universal metals to create highly active catalysts and using plants and microbes to recover rare metals from waste. **(4)** ***Research platforms*** – using state-of-the-art infrastructure to provide metabolomics and chemical biology platforms to institutes in Japan and abroad.

Center for Integrative Medical Sciences (IMS) pp. 8, 10, 11, 29

IMS 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 diseases with comprehensive analysis of the genomic diversity in individuals and identification of the genetic causes of disease and drug responsiveness. Its 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.

Center for Emergent Matter Science (CEMS) pp. 13, 14, 16, 36

Scientists at CEMS 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 are using physics, molecular chemistry and quantum electronics to generate novel materials and processors. 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.

BioResource Center (BRC) pp. 8, 17, 34

BRC in Tsukuba collects, preserves and distributes an extensive range of biological resources required for academic and industrial research. These include experimental mice, experimental 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 these materials to researchers inside and outside Japan since 2001, and has been providing extensive information about them, including training courses.

SPring-8 Center (RSC) pp. 13, 19, 22, 29, 33, 34

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 RSC, 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 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.

Nishina Center for Accelerator-Based Science (RNC) pp. 12, 15, 17,18, 20, 28, 32

RNC on the Wako campus is a world-leading accelerator facility for theoretical and experimental nuclear physics research. It is named after Yoshio Nishina who constructed Japan's first (and the world's second) cyclotron at RIKEN in 1937. The Nishina Center was established in 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 (RIBF), with its world's first superconducting ring cyclotron and superconducting radioactive isotope beam separator started full-scale operation. The Nishina Center collaborates with researchers around the world.

Center for Advanced Photonics (RAP) pp. 13, 18, 19

RAP 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 as 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 nano-world visible; using meta-materials 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.

Advanced Institute for Computational Science (AICS) pp. 19, 26, 32, 36

With their high computational speed and exceptional precision in simulations, supercomputers have become indispensable to research and development in many fields. AICS was established in Kobe in 2010 to operate Japan'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 groundbreaking 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.

Subluminal outreach

You can find out more about RIKEN's centers, laboratories, and researchers, as well as the newest breakthroughs through our main website, social media outlets, and RIKEN Research magazine.

Our homepage

From the RIKEN English homepage you can find detailed information about each center, program, and laboratory. Additionally, you will find a directory with contact information for RIKEN's lab heads.

You can also find details regarding RIKEN's worldwide educational and research partnerships, shared resources, and collaborations with industry.

Hot off the press!!

Keep up to date on the latest breakthroughs at RIKEN by following us on Facebook (RIKEN.english). We regularly post links describing our newest and best research, so you will know what we're accomplishing as soon as it has been published.

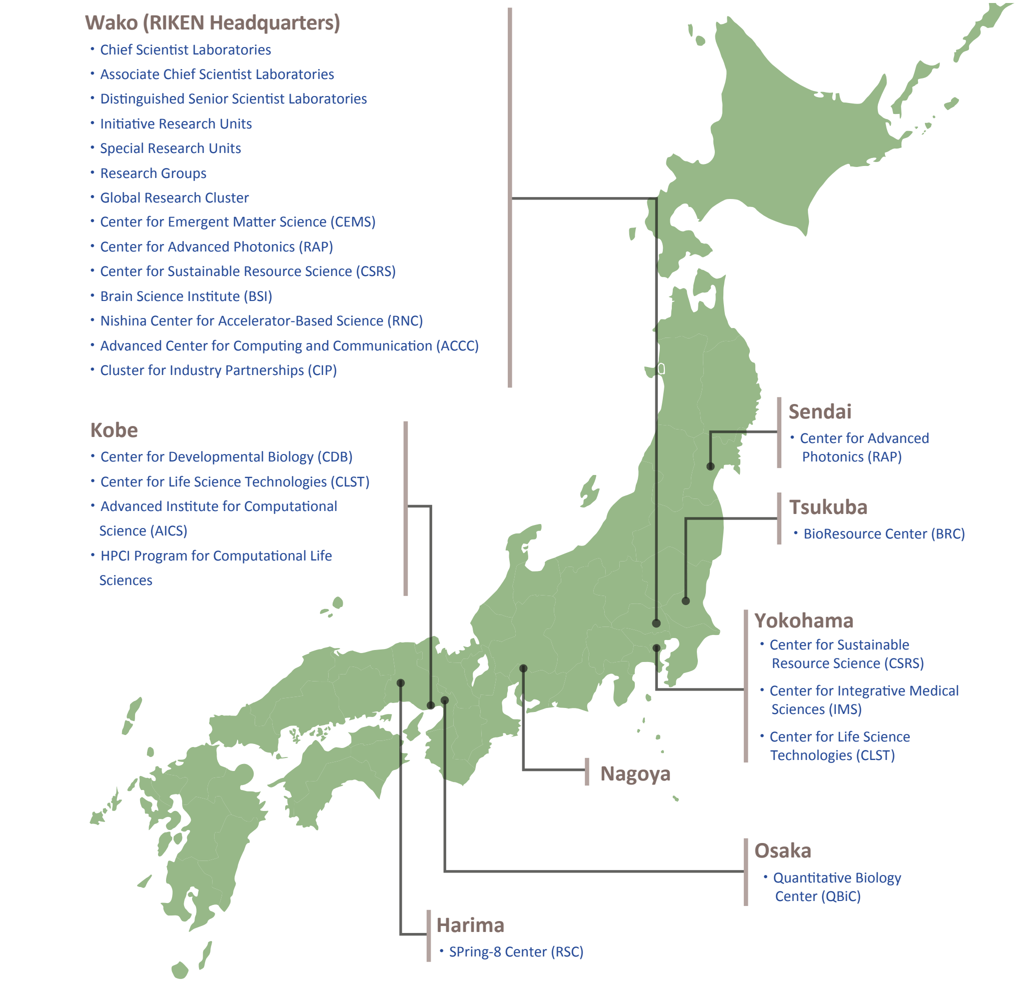
If Facebook isn't your thing, we also have a popular Twitter feed (riken_en), and a Youtube channel (rikenchannel) that includes videos in both English and Japanese.

Blogging & beyond

Our Global Communications team has recently started a blog called It Ain't Magic as a way to give a lighter background to what we are doing, explain some of the science behind our discoveries, and have more interaction with those of you who are interested in science and RIKEN. Comments are welcome!!

RIKEN Research

We also publish RIKEN Research, a free quarterly magazine that includes our best research, interviews with top scientists, and ideas about how RIKEN's research can benefit society. RIKEN Research Highlights are also available weekly online.



Asia

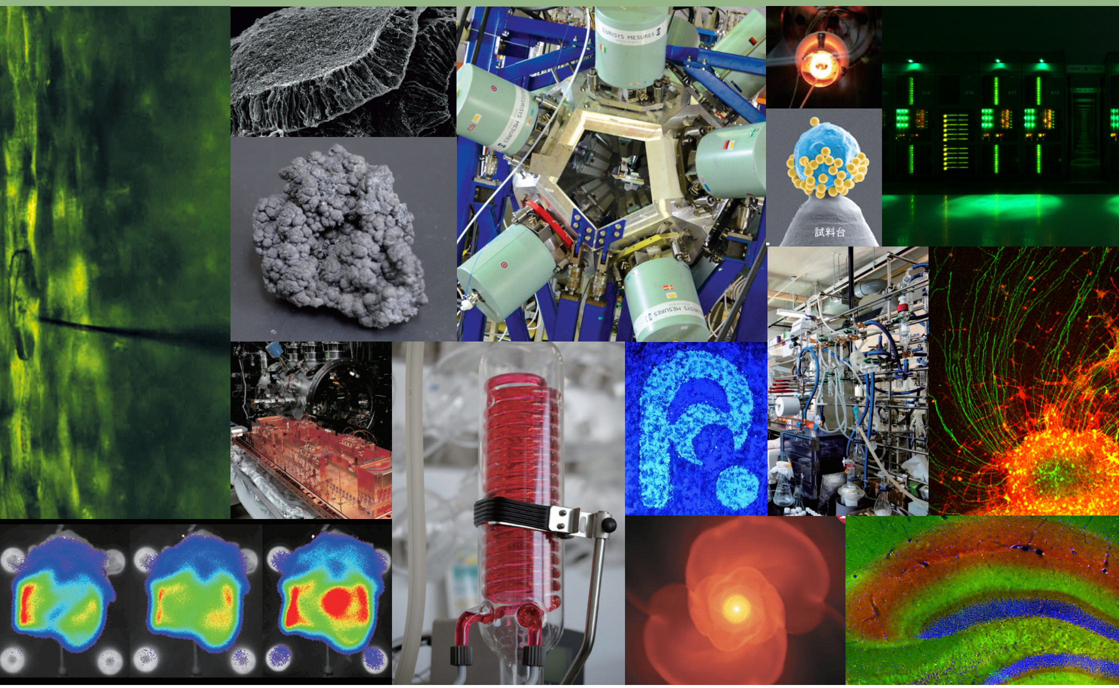
- RIKEN Tsinghua Research Groups (China)
- RIKEN-XJTU Joint Research Center (China)
- RIKEN-SJTU Joint Research Center (China)
- RIKEN-SIOM Joint Research Laboratory (China)
- NCTU-RIKEN Joint Research Laboratory (Taiwan)
- RIKEN-KRIBB Joint Research Center (S. Korea)
- USM-RIKEN International Center for Aging Science (Malaysia)
- RIKEN-NCBS Joint Research Center (India)
- RIKEN-JNCASR-IISc Joint Research Center (India)
- RIKEN Beijing Representative Office
- RIKEN Singapore Representative Office

North America

- RIKEN-MIT Center for Neural Circuit Genetics (USA)
- RIKEN BNL Research Center (USA)

Europe

- RIKEN-Max Planck Joint Research Center (Germany)
- RIKEN-KFU Joint Research Labs (Russia)
- RIKEN Facility Office at RAL (UK)



Visit Us Online!

Nov. 2015
RIKEN 2015-062