

Annual Report on Research Activities

2011

Preface

Ritsumeikan University, Vice President (Research Affairs)

Kozo WATANABE



The mission of universities, as stipulated in Japanese law, is to conduct educational and research activities with a focus on academics, share those results with society at large, and contribute to the development of society. Research is especially subject to high expectations to give the knowledge and results gained through research activities back to the educational field, as well as give research results back to society at large.

In 1994, Ritsumeikan moved the College of Science and Engineering to the Biwako-Kusatsu Campus (henceforth, BKC) and took advantage of the opportunity to promote industry-academia-government collaboration. Thus, by giving back the University's Knowledge and Skills, Ritsumeikan contributed to society, improved its quality as a university, and promoted the advancement of education and research.

As a result of these efforts, we have been able to increase our external research funds from corporate, governmental, and other groups. Especially from the point of view of the strengthening of basic research, the number of projects chosen for Grants-in-Aid for Scientific Research is largely increasing. Also, as independent strategies to strengthen basic research, Ritsumeikan has formulated Advanced Research Programs at Ritsumeikan University that take into account the characteristics of research fields.

Looking at research hubs at Ritsumeikan University, three programs, Digital Humanities Center for Japanese Arts and Cultures, Ars Vivendi: Forms of Human Life and Survival, Global Center of Excellence for Education, and Research and Development of Strategy on Disaster Mitigation of Cultural Heritage and Historic Cities, have been selected by Japan's Ministry of Education, Culture, Sports, Science and Technology as a part of our efforts in the formation of globally excelling educational research hubs. Also, through four research organizations, Ritsumeikan Global Innovation Research Organization(R-GIRO), Kinugasa Research Organization, BKC Research Organization of Social Science and Research Organization of Science and Technology, as well as the research institutes and centers established under these research organizations, we have developed organizational and academic research, and strengthened research systems to make industry-academia-government collaboration and research exchange more active.

To advance these research activities to the next level, in 2006, Ritsumeikan formulated the "Ritsumeikan University Research Enhancement Mid-Term Plan Phase I (AY 2006-2010)" and to further continue the plan progressively, formulated the "Ritsumeikan University Research Enhancement Mid-Term Plan Phase II (AY 2011-2015)" in 2011. With this plan, we are making efforts towards our objective of further vitalizing research.

With the intention of making our University's research activities, research results, and research-related data available to society, we have decided to publish this report on research activities. Using this first issue as a new starting point, with this publication, we would like to release various research results from our University from here on, and develop an outstanding "Annual Report on Research Activities".

September 2012

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Research Vision

Ritsumeikan University formulated the “Ritsumeikan University Research Enhancement Mid-Term Plan (AY 2006-2010)” in 2006. It has been designated as the Phase I Research Enhancement Mid-Term Plan, and the Research Enhancement Mid-Term Plan formulated in 2011 has been designated as the “Ritsumeikan University Research Enhancement Plan Phase II (AY 2011-2015)” (henceforth, the

“Phase II Plan”), representing a five-year plan.

The Phase II Plan has defined the following goals to take action toward the realization of the “Challenge to Create a Distinctive Research University which Contributes to Humanity, Nature and Society,” which is part of the vision of the Ritsumeikan Trust toward the year 2020.

Principles of Research Enhancement

- (1) By giving the knowledge and results gained through research activity back to education and providing society with the fruit of research results, contribute to the welfare of mankind, social progress, world peace, and the development of local communities.
- (2) Promote research that sets of Ritsumeikan University apart by emphasizing both scientific research based on the free, creative intellectual interests of individual researchers, and policy-driven research emphasized by the university, and by integrating them at times.
- (3) Increase functions that integrate research and graduate school education and endeavor to develop young researchers.
- (4) Strengthen collaboration with overseas research institutions and promote the internationalization of research activity and dissemination of research results both inside and outside of Japan.
- (5) Promote research activity in collaboration with national and local governmental agencies, private-sector industries, non-profit agencies and other organizations.

Basic Goals

- (1) Establish Ritsumeikan University as a university with top-class domestic research capabilities and aim for recognition as a university with a unique research base and research fields as well as high international standards.
- (2) Constantly strive for even higher research standards, and promote the creation of a climate where researchers ambitiously engage in research and the creation of a research environment which supports research activity.
- (3) Through industrial-academic-government partnership activities, promote commissioned and collaborative research with national and local government agencies and industry, and use the research results to benefit society, therefore giving back to society.

Implementation Policies for Goal Attainment

- (1) Promotion of original and diverse research
- (2) Creation a world-class research base
- (3) Reinforcement of the activity bases of research organizations, research institutes and research centers
- (4) Promotion of the internationalization of research activity
- (5) Strengthen the dissemination of research results both in Japan and overseas
- (6) Development of young researchers and others who will lead the next generation
- (7) Creation and expansion of a research environment and research support functions
- (8) Promote using research results to give back to society
- (9) Disseminate information on the status of research activities

Strengthening Basic Research

Promotion of Diverse Research with a Focus on Grants-in-Aid for Scientific Research

At Ritsumeikan University, we implement research support systems within the University budget, which lead to the acquisition of external grants such as Grants-in-Aid for Scientific Research (henceforth, KAKENHI), and endeavor in the development and enrichment of research content, a process on which we place great importance. As a result, the number of proposals selected for KAKENHI

considerably increased from 210 in 2005 to 411 in 2011 (the rank rose from number 40 nationwide in 2005 to number 29 in 2011). Ritsumeikan University will continue to position KAKENHI as a key source of external research funding, make efforts toward increasing the number of selected proposals and the monetary amount, and promote basic research.

Expansion of the Advanced Research Programs at Ritsumeikan University

We are endeavoring in the expansion of our research capabilities and have established the following various

Advanced Research Programs:

Advanced Research Programs at Ritsumeikan University

(1) Program to Support General Research Activities (Kiban-kenkyu)

This is a research grant to support and strengthen diverse research within the university, and is a system that aims to actively introduce external research funding such as KAKENHI to further develop and promote research content.

(2) Program for Application of the Grants-in-Aid for Scientific Research (KAKENHI)

The purpose of this system is to support applications the following year for rejected research topics in which a researcher applies for KAKENHI as a Principal Investigator.

(3) Program for Research of Young Scientists (Wakate-kenkyu)

This system supports and strengthens scientific research by young scientists at the university.

(4) Program for Post Doctoral Fellowship

The purpose of this system is to expand a wide range of basic research by the Ritsumeikan University faculty and promote the creation of research results by increasing the number of young research staff in addition to developing young researchers who can be active in educational and research institutions and industries, etc. (as researchers) both domestically and abroad.

(5) Program for Promotion of Academic Publication

The purpose of this system is to support outstanding research results in specialized fields and young researchers, as well as promote the international dissemination of research results in foreign languages such as English.

(6) Program for Promotion of International Research

The purpose of this system is to promote the international

dissemination of research results in order to promote the enhancement and internationalization of research activity.

(7) Program for Overseas Travel Support

This system subsidizes travel expenses required to present the results of research or create international networks for the purpose of promoting the international dissemination of research findings.

(8) Program for Research Institute Mission

This system supports the endeavors for focused projects based on the comprehensive plan established by each laboratory. The purpose of this program is to promote the development of young researchers in addition to creating a positive reputation for the laboratory.

(9) Program for Core-to-Core Research

The purpose of this system is to establish a world-class research hub (Global COE Program, MEXT) that meets the standards of Ritsumeikan University from a mid- to long-term standpoint.

(10) Program for the First-Phase R-GIRO Research (Specific Topics for Sustainable Society)

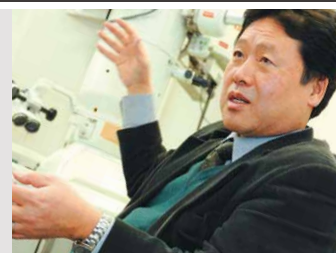
The purpose of this system is to create a new core for a research hub specifically for research areas which Japan must urgently solve (environment, energy, food, materials/resources, medical care, health, peace of mind/safety, people/way of life, peace/governance, Japan research/area studies) at the Ritsumeikan Global Innovation Research Organization, which is under the direct supervision of the University President, while developing the young researchers who will lead the next generation.

Grants-in-Aid for Scientific Research

Creation and Evaluation of High-Functioning Materials with Nano-Meso Harmonic Structure Control

Scientific Research (B)
AY 2009-2011

College of Science and Engineering
Professor **Kei AMEYAMA**



Outline of Research Goals

The number of elements that humans can use is of merely around one hundred, and moreover, in actuality that number is further limited due to its scarcity or toxicity. In particular, Japan lacks natural resources, and there is a pressing need to open a path to the future with scientific technology which makes it possible to effectively utilize limited elements that can perhaps be used to create materials in order to construct a renewable societal infrastructure in severe resource conditions.

In this context, structural materials are required to have superior mechanical characteristics while reducing the

requirement for rare earth elements. By doing this, it can be linked to the construction of a low carbon society which conserves resources, conserves energy, reduces carbon emissions and recycles, a recycling-based society, and a society which lives in symbiosis with nature.

The purpose of this research was to conduct nano-meso harmonic structure control on metallic and ceramic structural materials, and to give them both high strength (high hardness) and high ductility (high toughness), which had not been possible up until now.

Outline of Research Results

Originally, the enhancement of structural material functionality was advanced through the approach of homogenization and grain refinement down to the ultrafine scale. In contrast, this research conducted nano-meso harmonic structure control, which harmonically arranges both ultrafine grains (nanocrystal grains) and large-grain crystals (meso crystals), based on the concept of “heterogeneity, harmony, and ultrafine-grain refinement,” which is completely different from what is currently available. In addition to establishing a materials design policy where structural materials can possess both high strength (high hardness) and high ductility (high toughness) with “nano-meso harmonic structure control,” the mechanism of its functional enhancement was clarified.

In harmonic structure metal materials, while enhancing strength with harmonic organization, it became clear that major uniform elongation was greatly improved in the deformation structure as well. The chart below is a

comparison of the characteristics of several harmonic structure metallic materials and conventional structure materials. It can be seen that all the materials possess both strength and ductility. This makes practical applications of structures that are light, compact and have superior reliability possible. Also, contributions to the medical and welfare fields can be anticipated.

On the other hand, in harmonic structure ceramic materials, it was evident that, through the dispersion of stress concentration and suppression of crack development, fracture toughness improved along with the hardness. This brings about the possibility of substituting extremely abundant Si, Al, carbon and nitrogen, etc. for Zr and Y, which are rare, high quality elements and are the primary components of yttria (Y_2O_3) doped zirconia (ZrO_2) ceramic, which are often used as high-toughness ceramics. In this way, the content of rare elements can be reduced, and moreover, light, high-performance ceramics can be used.

	Improvement in Tensile Strength (Comparison at the same Elongation)	Improvement in Elongation (Compared at the same Strength)
SUS316L Stainless Steel	× 1.5	× 3.0
Pure Titanium	× 2.0	× 1.9
Ti-6Al-4V Alloy	× 1.3	× 1.8
Pure Copper	× 1.2	× 6.0 (Uniform Elongation)

Grants-in-Aid for Scientific Research

Development and Clinical Application of a Non-Contact Sleep Diagnostic Method for Children

Grant-in-Aid for Young Scientists (B)
AY 2010-2011

College of Science and Engineering
Assistant Professor **Shima OKADA**



Outline of Research Goals

We focused on the strong relationship between sleep stage and bodily movement, proposing a non-restrictive, non-contact method for monitoring childhood sleep. We adopted the difference video image processing for detecting the bodily movements in noncontact way. This technique revealed the strong relationship between sleep depth measured by polysomnography (PSG) and the bodily movements detected from motion images. However, in order to establish a non-contact sleep stage measurement method as a future substitute to PSG, it is necessary to estimate the sleep depth from bodily movement data alone.

Therefore, a non-contact sleep estimation method was developed for children. We proposed new sleep estimation method for children to apply linear discriminant analysis to bodily movement data measured by video recording. This method was designed to estimate sleep stage using only body movement data obtained from video images. In addition, we applied this technique for screening of childhood developmental disease because the bodily movement during sleep with developmental disease is different from that of normal developed children.

Outline of Research Results

The purpose of this study was to develop sleep monitor systems for children using a non restrictive way, and to this end we proposed a new diagnosis method for developmental disorders.

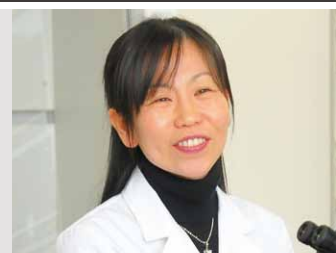
We examined normal developed children using (PSG) and video analysis. The linear discriminant analysis was used to estimate the sleep stage from bodily movements calculated from video image. The continuous time of non-movement and the amount of body movement were included as independent variables. The three sleep stages, Wake, Light sleep & REM(Rapid Eye Movement) sleep, and Deep sleep, were included as response variables. Overall, the estimates generated by our method showed strong agreement with PSG results. The average agreement rate for sleep stage was approximately 70%.The results revealed that the transition

between sleep stages could be successfully estimated by body movement during sleep.

Next, the initial goal was the establishment of a sleep depth estimation specifically to bodily movements for children with developmental disease. However, the patterns of the bodily movements with developmental disease are significantly different than those of normal developed children, so it was difficult to establish a sleep depth estimation method by using bodily movement. Thus, we made a comparison between normal developed children and children with developmental disease in bodily movement by video images as a clinical application. As the results, there was a remarkable difference in deep sleep and we suggest that this difference may be used as a marker in the diagnosis of developmental disease.

Grants-in-Aid for Scientific Research

The Influence of Lowered Intestinal Function on Inflammations in Skeletal Muscles and the Regenerative Process

Grant-in-Aid for Young Scientists (B)
AY 2009-2011College of Sport and Health Science
Assistant Professor **Kaori MATSUO**

Outline of Research Goals

Although there is a close relationship between overtraining by athletes and lowered intestinal function, the influence lowered gastrointestinal tract function has on skeletal muscle is not yet clear.

Also, on the other hand, disuse muscle atrophy (sarcopenia) in the elderly is considered to be muscle atrophy due to aging, so exercises such as muscle training are promoted as a way to prevent sarcopenia. However, attention has been paid to the possibility that the cause of sarcopenia is not just

mere atrophy of the skeletal muscle.

Therefore, the purpose of this research project is (1) to prove the hypothesis that lowered gastrointestinal tract function delays the recovery of damaged muscles, and (2) to investigate the possibility that the cause of sarcopenia in the elderly is related to lowered digestive function due to aging. Furthermore, (3) this project attempted to identify the factors involved in gastrointestinal tract function and skeletal muscle repair-regeneration mechanism.

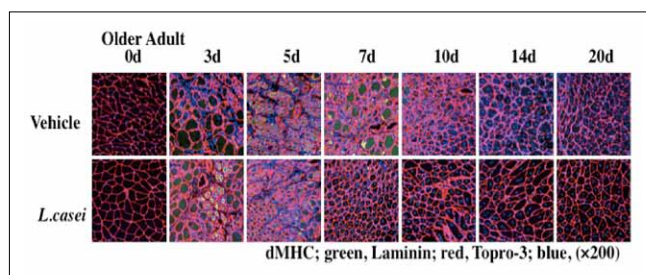
Outline of Research Results

This research investigated the role of commensal bacteria in the restoration process of skeletal muscle, as well as whether the repair-regeneration process for damaged skeletal muscle is improved through the intake of probiotics (*Lactobacillus casei*; *L. casei*), which maintains gastrointestinal tract function. The results suggest that commensal bacteria contributes to the regeneration of skeletal muscle.

In mice that had commensal bacteria removed, the skeletal muscle repair process was delayed, and improvements were seen when they were administered lipopolysaccharides, which is the bacterial component in commensal bacteria. Also, when it was investigated whether *L. casei* were effective in skeletal muscle repair, in young mice whose gastrointestinal tract functions did not yet show signs of aging, changes were also seen in the post-muscular damage recovery process in the

group that was administered *L. casei*, yet for the aged mice, no improvement was seen in the regenerative process for damaged skeletal muscle with *L. casei* administration. These confirmed the relationship between the aging and lowering of gastrointestinal tract function accompanied by increasing age and the regenerative process for skeletal muscle. The results of this research showed the relevance of “gastrointestinal tract function and skeletal muscle repair-regeneration” to the relevance of stress and gastrointestinal tract function thus far.

These results of this research will not just be utilized for improving reduced gastrointestinal tract function in athletic over-training, it is also expected to contribute to the front lines and be useful as basic information for intestinal conditioning for the elderly and for kinesitherapy and exercise prescriptions.



Repair process of the damaged muscles of aged mice using immunohistochemical staining

Grants-in-Aid for Scientific Research

The Self-Organization of Gold Nanoparticles using Liquid Crystals and Light Manipulation of the Structural Organization

Grant-in-Aid for Young Scientists (B)
AY 2009-2011

College of Life Sciences
Associate Professor **Osamu TSUTSUMI**



Outline of Research Goals

In this study, we developed new hybrid materials consisting of metal nanoparticle and photochromic liquid crystal molecules. Special attention was paid to control aggregation structure of the materials in nano-meter scale.

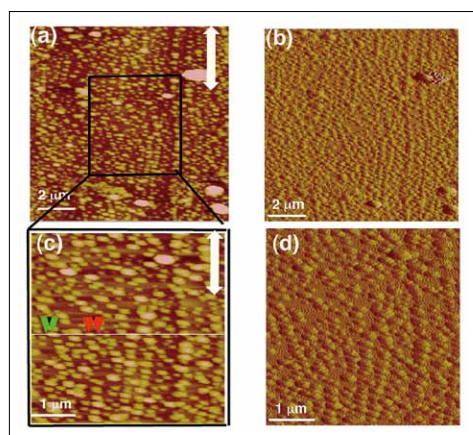
Recently, metal nanoparticles have attracted great interest because of their unique physical and chemical properties based on the quantum-size effects. Therefore, they have been expected to be applicable to novel materials for the electronics, photonics, and magnetic devices. In terms of device application, the nanoparticles should be arranged in the ordered structure, and it is interest to control

the nanostructure of the ordered metal nanoparticles. To date, the special arrangements of the metal nanoparticles by means of the liquid crystal molecules have been investigated, and the spontaneous arrangements of the nanoparticles have been accomplished by using a rod-like liquid crystal and discotic liquid crystal molecules. In this study, we used photochromic liquid crystals to arrange the metal nanoparticles. We can expect that the spatial arrangement and distribution of the metal nanoparticles could be precisely controlled by light by the use of photochromic liquid crystals.

Outline of Research Results

We explored control of the aggregation structure of gold nanoparticles by self-assembly of liquid crystals as well as manipulation of their aggregation structures by external stimuli. On a graphite substrate, linear aggregation structure of the gold nanoparticles was observed. In addition,

on a substrate with a alignment layer, we can align the nanoparticles to the desired direction. We also found that irradiation of the gold nanoparticles with UV light induced mass transfer of the nanoparticles from the irradiated area to non-irradiated area.



AFM image of Au-LC on a glass substrate coated with polyimide alignment layer.

(a): Topological image (8 μm \times 8 μm)

(b): Differential image of (a)

(c): Expansion of the topological image (4 μm \times 4 μm)

(d): Differential image of (c)

The arrows in (a) and (c) indicate the rubbing direction.

Grants-in-Aid for Scientific Research

Comparative Study on Social Rehabilitation Support Consistent with New Criminal Justice Procedures for the Offenders with Disabilities

Grant-in-Aid for Young Scientists (B)
AY 2010-2011College of Law
Associate Professor **Chie MORIHISA**

Outline of Research Goals

In recent years, disabled persons have been led to make statements that differ from the facts during the investigative and trial phases, unable to understand the meaning of criminal procedures or the situation they have been placed in, and it has been pointed out that from being treated as an ordinary person up to the penal phase, there is the danger of false accusations, and they have a tendency to be judged more harshly than the actual circumstances merit, as it is difficult for them to act according to the circumstances, and do not defend themselves or express remorse, etc. In Japan, where the mentally disabled are deemed to be

legally competent and are prosecuted according to ordinary procedures, social support must be pursued so that there are procedures appropriate for disabled persons and that physical confinement is avoided to the greatest extent possible, along with preventing repeated recidivism and incarceration in prisons by increasing support while they are serving their sentences.

Therefore, the purpose of this research is to logically and empirically demonstrate what appropriate criminal procedures for the disabled should be based on comparisons with foreign countries.

Outline of Research Results

The findings of this research showed the Community Living Establishment Centers, etc. created in recent years, and the appropriate interventions in providing legal and social support have contributed to a certain degree to consistent support up to guaranteeing appropriate procedures particularly for disabled people, as well as independent social rehabilitation. On the other hand, they have also exposed a perception gap toward social rehabilitation between the judiciary and social welfare, and the insufficiency of social support for general criminal offenders.

Also, this research examined, for example, as procedures based on the principles of protection for the disabled and social rehabilitation, when creating procedures for the disabled, what kind of procedures make it possible to

guarantee appropriate procedures particularly for disabled persons, similar to juvenile court proceedings, pre-sentence reports by social workers during the sentencing phase in foreign countries and the submission of support plans, or referring to penalty revision systems, etc. Prior to separate procedures, even in existing procedures, it was possible to elicit situations where insights by non-judicial social workers, etc., such as how to appraise the circumstances, and its methods could be elicited. In particular, when searching for a vision to socially rehabilitate criminal offenders, it is important that it can become an effective support for the first time, emphasizing independence and volition.

Future research shall examine desirable forms of social rehabilitation while expanding the subjects to general criminal offenders.

Grants-in-Aid for Scientific Research

Co-Residency Behavior of Unmarried Young People and Their Parents

Grant-in-Aid for Young Scientists (B)
AY 2010-2011

College of Economics
Associate Professor **Kei SAKATA**



Outline of Research Goals

From the latter half of the 1990s, “parasitic singles” have garnered attention in parallel with an increase in “freeters.” There has been intense debate on parasitic singles, with one interpretation stating the cause is a change in the perceptions of the young (a change in the labor-supply side), such as a lowered desire to work, lowered sense of independence, and a heightened dependence on their parents; the interpretation from the labor-demand side is that it is a phenomenon accompanied by decrease in demand in the youth labor market, which became prominent in the latter half of the 1990s. However, there is no empirical research which provides a conclusion to these debates. Also, the relationship between co-residency, parent (child) life satisfaction, and financial transfers is unclear.

This study analyses the factors involved in unmarried adult children living with their parents, and the influence on the degree of satisfaction co-residency gives the parent and the unmarried adult children. Previous studies overseas analyse co-residency with adult children and their parents

from the child’s viewpoint, such as the youth labour market and the housing environment. However, previous research lacks perspective on why parents co-reside with their adult unmarried children in the first place. Therefore, this study examines to what extent co-residing with their unmarried adult children has impacts on the degree of parent (child) life satisfaction using the “National Family Research” (Japan Society of Family Sociology). This study takes into consideration income transfer between the two generations. In the analysis pertaining to the parents, regarding co-residence with unmarried adult children, (1) the degree of the father’s satisfaction when co-residing with at least one son, (2) the degree of the mother’s satisfaction when co-residing with at least one son, (3) the degree of the father’s satisfaction when co-residing with at least one daughter, and (4) the degree of the mother’s satisfaction when co-residing with at least one daughter were estimated using a matching method (propensity score matching) in these four cases.

Outline of Research Results

As a result of the analysis, co-residence had no influence on the child’s degree of satisfaction, but it was shown that it decreased the parent’s degree of satisfaction. Furthermore, financial transfers from parent to child does not increase the probability of co-residence, but financial transfers from child to parent increased the probability of co-residence, and it can be interpreted that children are compensating for their parents’ dissatisfaction by making financial transfers to them.

Also, looking at the degree of satisfaction in co-residence between mothers, fathers and children in detail, co-residing with their children has no significant effects on the father’s degree of satisfaction, but it has negative and significant

effects on the mother’s degree of satisfaction. Furthermore, co-residing with a daughter does not reduce the mother’s degree of satisfaction, but co-residing with a son decreases the mother’s degree of satisfaction. It could be seen that the housework burden due to co-residence contributes to reducing the mother’s degree of satisfaction.

The results of this research were presented at both domestic and overseas academic conferences and workshops, and one of the papers has already been published in a refereed international journal. The other two articles have been submitted to refereed international journals.

Advanced Research Programs at Ritsumeikan University

Recycling Cerium Oxide for Glass Polishing

Program for Application of the Grants-in-Aid
for Scientific Research (KAKENHI)

College of Science and Engineering
Assistant Professor **Junji MURATA**



Outline of Research Plan

In recent years, products which use glass as its base material – representative examples being the substrate for flat panel displays (FPD) for liquid crystal display televisions, the substrate for magnetic disks for hard disks, as well as various types of optical elements, such as lenses and mirrors – are used in various fields. These products are processed in accordance with their use, and since ultimately they increase the permeability or reflectivity of light, the surface will be smoothed by polishing. For glass finishing, cerium oxide are typically used as the abrasive agent. Compared to other abrasive grains, cerium oxide have considerable advantages, such as obtaining a high polishing efficiency, and high-quality finishing being possible. However, the Chinese government has placed export restrictions on rare earths such as cerium, and the price of cerium oxide abrasives has skyrocketed. Under these circumstances, technology which reduces the amount of cerium oxide in glass polishing is required.

Therefore, this study conducts research on recycling

cerium oxide abrasives in the precision polishing of glass. First, the composition changes in abrasive grains and polishing slurry are evaluated through a variety of analyses, and the controlling factors regarding the decrease in polishing efficiency are extracted. High-temperature annealing or mechanical milling will be examined as the treatment to recreate the change of grain shape and structure discovered through analysis of the abrasive grains and the polishing slurry. Moreover, chemical treatment to remove contaminants on the surface of the abrasive grains will be tested. Also, in addition to supplementing components lost in the polishing slurry with chemicals and ions, as a process for removing processed components from the polishing liquid, separation of the abrasive particles from the polishing liquid via filtration, and regeneration will be considered. An optimal recycling treatment method will be developed by repeating these analyses and treatments.

Outline of Research Results

In this study, slurry containing cerium oxide abrasives was circulated and used to polish glass, and the material removal rate was evaluated. The removal rate monotonically decreased with the polishing time, and it was confirmed that after 300 minutes of polishing, the initial removal rate dropped to 70%, and after 900 minutes, it dropped to 30%. Next, in order to elucidate the cause of the degradation of removal rate, the cerium oxide abrasives used for polishing were analyzed. First, as a result of observing the shape of the abrasive particles using a scanning electron microscope (SEM), there was no major change in the shape of the abrasive particles before and after polishing, also, no deposits, etc. were observed on the surface of the abrasive particle after polishing.

Next, an analysis of the components contained in the abrasive particles was performed using energy dispersive X-ray analysis (SEM/EDX). Peaks of fluoride were observed from

the abrasive particles of cerium oxide before polishing. On the other hand, although fluoride was detected from the abrasive particles after polishing as well, it was confirmed that the strength of the peaks were reduced by half compared to before polishing. Fluoride components, as represented by hydrofluoric acid (HF), is known for dissolving glass, and a decrease in the fluoride components contained in abrasive particles of cerium oxide is thought to be a cause for the degradation of the removal rate. Therefore, restoration of polishing capacity was attempted by adding fluoride to the abrasive particles of cerium oxide with diminished polishing capacity. As a result of adding fluorides such as LaF, NdF and CeF to the cerium oxide abrasives and evaluating its polishing characteristics, improvement was attained in the polishing characteristics when CeF was added, and characteristic improvement of cerium oxide with diminished polishing characteristics was successful.

Advanced Research Programs at Ritsumeikan University

Synthesis of Solar Battery Cells Using Microorganisms

Program to Support General Research
Activities (Kiban-kenkyu)

College of Life Sciences
Associate Professor **Hisaaki MIHARA**



Outline of Research Plan

There is increased demand for solar power generation as a form of next-generation energy. Attention is especially being paid to Cu(In,Ga)Se₂ membrane solar batteries (CIGS membrane solar batteries). It is extremely promising as a next-generation solar battery because there is little worry that the four elements (Cu, In, Ga, and Se) will fall into a dangerous supply shortage, and their prices are also stable. However, one problem is that the synthesis of CIGS membranes consumes a lot of energy, as it uses a method called “vapor deposition,” where the four material elements are vaporized and made to react at a low pressure and high temperature.

Also, problems are expected to occur in the recovery of the component elements from solar batteries that can no longer be used because their electrical generation efficiency has dropped. Metal nanoparticulation using microorganisms

has been the focus of a great deal of attention in recent years because it is an environmentally-conscious, inorganic material synthesis technique which can be performed at room temperature and ordinary pressure. On the other hand, the molecular mechanism regarding the synthesis of nanoparticles is completely unclear. In order to establish a basis for the production method of CIGS semiconductors using microorganisms, this study focused on bacteria with a high ability to metabolize selenium and attempted to clarify the molecular mechanism of selenite/selenate reduction and nanoparticle formation. Synthesis of semiconductor nanoparticles such as copper selenide and indium selenide, which are composed of two types of elements, was also attempted.

Outline of Research Results

Six strains of *Bacillus* sp. were isolated from the soil. When they were cultivated under aerobic conditions in Tryptic Soy Broth (TSB) containing 5mM of selenite or selenate, accumulation of red-colored elemental selenium was observed in both of the selenite-containing culture and the selenate-containing culture of a NTP-1 strain. Elemental selenium (200 mg/mg-dry cell weight) was accumulated in the medium containing selenite. Using a scanning electron microscope, nano-sized particles thought to be elemental selenium were observed the outside of the bacteria cell.

On the other hand, an accumulation of selenium was observed only in the medium containing selenite for the other five bacterial strains. In order to investigate the subcellular localization of selenite reduction activity, the activity of sonicated bacterial lysate was examined. Activity was detected in the insoluble fraction of all of the

bacteria, suggesting that selenite reductase is a membrane-bound protein. Next, the structure and atomic composition of the obtained particles were analyzed by using an energy dispersive X-ray analyzer and a scanning electron microscope. When the NTP-1 strain was used for the selenite reduction, uniform selenium particles were formed. In contrast, irregular, amorphous selenium was formed when selenite was chemically reduced using dithiothreitol. Furthermore, when the NTP-1 stain was cultured in a medium containing selenite and copper chloride, a membrane-like material was formed. As a result of analysis using an energy dispersive X-ray analyzer and an electron scanning microscope, selenium and copper were co-distributed on the membrane-like material, suggesting the formation of a copper selenide membrane.

Advanced Research Programs at Ritsumeikan University

Development of Bodily Communication Games in a Day-Care Space Using Environmental and Bodily Sensors

Program to Support General Research
Activities (Kiban-kenkyu)

College of Image Arts and Sciences
Associate Professor **Shigenori MOCHIZUKI**



Outline of Research Plan

In the present day, which anticipates an aging society previously unknown, in addition to barrier-free technology and medical problems, there is the problem of how to improve quality of life (QOL, the quality of the general welfare of the life in the individuals and societies). This research, in addition to the current care works in the welfare facility, as a starting point takes the question of whether it is possible to start enjoying “the present situation” before recreation is possible/not possible in day nursing facilities for the elderly (day-care), which plays a part. Therefore, this research attempts to have the care space which create multichannel communication through interactive device systems – day-care games – where workers, users, and family members

function “together in the day-care,” linked to environmental and bodily sensors.

As a specific plan, 1) participant observation and a demand survey were conducted in day-care, and day-care games were developed using environmental devices and sensors. 2) The process of care/being cared for was made visible, and workshops were held in order to consider the play elements from physical and communicatory problems. Through these, we propose and study whether an “awareness” of enjoying the daily care work itself, which is apt to be taken as highly burdensome work and an alternative care model which creates a cycle of communication in this way.

Outline of Research Results

In this study, first, with Aiko Watanabe (graduate student, Graduate School of Core Ethics and Frontier Sciences) as a facilitator, and with the cooperation of the Nagahara Clinic, Jizaikan Kirakuya day-care facility (Kamigyo-ku, Kyoto City), participant-observation was conducted in the day-care space.

In addition, with the cooperation of Mamoru Metsugi (graduate student, Graduate School of Image Arts), and Osamu Jareo (dancer/choreographer), the problem points were extracted with the goal of changing nursing settings into a creative space using interactive technology with the multilateral viewpoint of “welfare, technology, art and the body,” a viewpoint different from conventional care work. As a result, this study adopted the policy of capturing in a multilayered manner the aspects of day-care space for both the workers and users, and the personal circumstances of

the users and family members who go there.

The former focused the development of interactive systems using environmental and bodily sensors in the day-care space, and giving feedback to the users and workers, and the latter focuses on developing bodily work in order to consider the play elements from physical and communicative problems. Also, workshops which combined the findings of the two were held, and from listening to the family members of users as well as workers, it could be assessed that the spouts for creating new communication channels in the day-care had taken hold.

Since the developed interactive system and device are in the testing stage, the necessity of further examination of the contents, and examination of ongoing methods of cyclical effort which involves workers, users and family members are future issues.

Strengthening Policy-Driven Research (Forming World-Class Research Hubs)

Endeavors Related to the Global COE Program

At Ritsumeikan University, three research hubs have been selected by the Global COE Program (henceforth, “GCOE Program”), MEXT: “Digital Humanities Center for Japanese Arts and Cultures”, “Ars Vivendi”, and “Global Center of Excellence for Education, Research and Development of Strategy on Disaster Mitigation of Cultural

Heritage and Historic Cities”. Ritsumeikan University supports research activities via the “Program for Core-to-Core Research,” an intra-university research support system to make these three hubs even more distinguished world-class research hubs.



Digital Humanities Center for Japanese Arts and Cultures (Art Research Center)



Ars Vivendi (SOSHIKAN HALL)



Global Center of Excellence for Education, Research and Development of Strategy on Disaster Mitigation of Cultural Heritage and Historic Cities (Research Center for Disaster Mitigation of Urban Cultural Heritage)

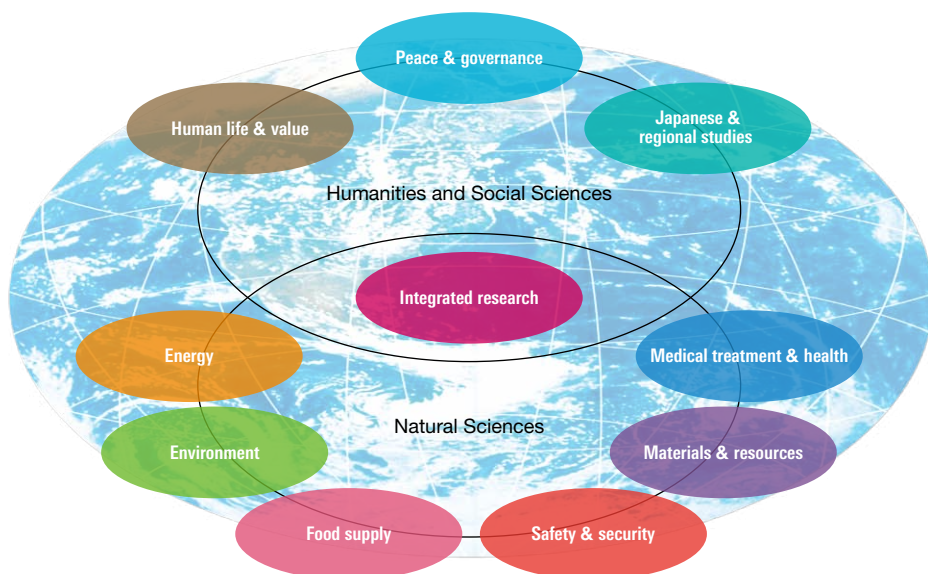
Endeavors Related to the Program for the First-Phase R-GIRO Research

(Specific Topics for Sustainable Society)

Ritsumeikan University aims to “create a sustainable, prosperous society,” and established Ritsumeikan Global Innovation Research Organization (henceforth, “R-GIRO”) in 2008 as a research organization to promote research in specialized research fields which Japan must urgently resolve. R-GIRO has defined policy-driven research areas and has developed the “Program for the First-Phase R-GIRO Research (Specific Topics for Sustainable Society)” in order to support the formation of distinctive research hubs, and 33

research projects (10 in the humanities and social sciences, 22 in the natural sciences and 1 in the interdisciplinary of humanities, social and natural sciences) are underway. Each project presents its research findings externally via symposiums and is engaged in the formation of research hubs. Also, focus is placed on developing young researchers who will lead the next generation, and young researchers such as post-doctoral fellows are developing research activities by participating in numerous projects.

Conquest of the important subject of the earth in the 21st century is challenged.
Aim at construction of human ecology society.



Global COE Program

Digital Humanities Center for Japanese Arts and Cultures

Graduate School of Letters
Professor **Ryo AKAMA**



Outline of Research Plan

As AY 2011 is the final year of the GCOE Program, while aiming at establishing a graduate school to succeed this Project, we will focus on fostering and supporting young researchers, as follows: 1) planning and managing the Educational Program of the Digital Humanities Center for Japanese Arts and Cultures, 2) dispatching young researchers overseas, 3) developing young researchers' management capabilities, and 4) educational collaborations with foreign research institutes.

As for the Center's research, it shall be conducted through the Center's five research groups: Kyoto Culture Group, Japanese Culture Group, Historical Geographic Information Systems Group, Digital Archiving Technology Group, and Web Technology Group.

We do promote interactions between research projects, actively support collaboration among researchers in different fields, and further collaboration and fusion between the Humanities and science.

For this fiscal year, we are planning the following:

1. We will have the 2nd International Symposium on Digital Humanities for Japanese Arts and Cultures (DH-JAC 2011) as a compilation of this Center's research and educational activities over the last five years.
2. We intend to disseminate our research outcomes through the Web more than ever in AY 2011.
3. We plan to promote an educational and research network in the DH field. In particular, as a DH center to represent Japan, our Center will put in an effort to networking among DH centers in the Asian-Pacific region.
4. We will publish Volumes 4 to 6 of *The Digital Humanities Center for Japanese Arts and Cultures*, a bilingual series which includes research outcomes by young researchers.
5. In addition to conducting ongoing joint research with overseas research institutions, we plan to start new joint research with the Freer Gallery of Art in the United States as well as the National Museum of Art in Poland.

Outline of Research Results

Each of the five Research Groups conducted research projects while giving consideration to educational effects on the young researchers.

(1) Kyoto Culture Group

Managing digital archives on Kyo-yaki (Kyoto ceramics) and their historical materials, designs for Yuzen textiles, materials on Kyoto film culture, and a full-text database of a clean copy of the *Hyohanki* (Taira-no-Nobunori's diary), and making the Kyoto Entertainment Information Database publically accessible on a trial basis. Also, held "Research Meetings on Medieval and Early-modern Genre Paintings" for exchanging information; and an international symposiums on cultural properties; workshops and exhibitions on religion; and expanding functions of the traveling-route maps of

Heian aristocrats and their applications for historical studies.

(2) Japanese Culture Group

Archiving data from research reports on the Jomon to Kofun period, which significantly improves the research environment for young researchers (ongoing project). Using the web makes us possible to conduct international joint research on materials related to *gaichi* Japanese language literature. Constructing databases of *kogei* (traditional handicrafts), *ukiyo-e* prints, and woodblock-printed books, held by foreign museums (ongoing project). Considerable accumulation of the printed books on the database, as well as our educational programs and workshops led to the start of various overseas projects using the databases of the *ukiyo-e* and printed books. Developing a Japanese music resource

database and “the Kabuki Digital Museum” (ongoing project). Starting building a Japanese Culture digital dictionary on ArtWiki.

(3) Historical Geographic Information Systems (GIS) Group

Reinforcing and updating contents of “Virtual Kyoto,” which led to addition of a VR (Virtual Reality) Edo Period (*Rakuchu-ezu*), as well as a VR Heian-kyo with more detailed building models on the VR Kyoto website. Our projects also include construction of database of modern Kyoto’s population statistics, and a GIS database of *Kyoto-shi meisai-zu* (*Large-scale Maps of Kyoto City*) and its online publication. Furthermore, GIS data of surveys on Kyo-machiya (traditional Kyoto-style houses) was prepared and made available for general use. Also, collaborating with the Digital Museum-related projects, funded by the Ministry of Education, and the Ritsumeikan Global Innovation Research Organization, we created a detailed street-view model for the parade of *yamahoko* floats during the Gion Festival.

(4) Digital Archiving Technology Group

While keeping on developing basic processing and analytical technologies for each research project, we have conducted: dance body motion analysis, “kansei” information processing on dancing, image analysis of historical

documents, technologies using “Second Life,” visualization research on various types of data, advanced searching technology, sound-data analysis of traditional performing arts, and precise modeling of fabrics and paintings based on their optical characteristics. Also, research on the Digital Museum Project was conducted in the form of synthesizing these research projects. We held the international symposium “Human Body Motion Analysis with Motion Capture.”

(5) Web Technology Group

1. Besides expanding functions of KACHINA CUBE, a coordinated archive creation support tool, our Group engaged in making social conflicts visible in historical events and establishing an understanding support method; 2. Using Linden Lab’s Second Life as a platform, our Group has built up a Japanese culture learning support environment, and designed and experimented its learning process for foreign participants; 3. Improved our videogame play information recording system and conducted its experiments on participants at international conferences; 4. Digitalizing game manuals and conducting their diachronic analysis using text mining; and 5. Implementing Ludoly, a database linked with various user-generated Web services, and enhancing its functions.



Digital Museum of the Gion Festival

Global COE Program

Ars Vivendi: Forms of Human Life and Survival

Graduate School of Core Ethics and Frontier Sciences
Professor **Shinya TATEIWA**



Outline of Research Plan

This program, which advocates “ars vivendi,” has implemented objectives 1-3 listed below in close collaboration with the program members, graduate students and post-doctoral fellows (henceforth, “PD”) while mutually interlinking them. Academic Year 2011 is the final year for the program, and under the research system established thus far, presentations via international conferences and media, writing academic papers or books, and international research cooperative relationships will be strengthened, and the findings will be disseminated. Also, a foundation for development after completion of the GCOE Program will be prepared by expanding the functions of the Research Center for Ars Vivendi, particularly strengthening availability of our research materials and activities to the scientific community and the public at large via the homepage.

(1) Accumulation and Thinking

What has occurred, been said, and been thought about the body and disabilities, aging, illness, and various differences, particularly in modern times will be accumulated, its content will be clarified in its entirety, made available to the public, and examined.

There will be further progress made on the construction of an archive on books related to the body and the creation of a book information database, which is already underway, will be continued. Moreover, publication of research findings reports at graduate student study groups, book publications

and dissemination of the program’s academic information in English, Korean and Chinese through the program’s homepage will be also continued.

(2) Reorganization of Studies

People who are experiencing differences and changes, and the people with them will participate in research, use science, and create a cycle and system for creating academic knowledge. As an example, in partnership with “Integrated Research of Accessible Ebooks: Interfaces & Services” (Research Program of the Ritsumeikan Global Innovation Research Organization (R-GIRO)), research on book accessibility for persons with reading disabilities, such as the visually impaired, will be conducted with the participation of the graduate student in question.

(3) Cooperation and Construction

This project will consider and demonstrate how people who have difficulties living in the world should live. Specific ideas will be presented while reporting on the research findings from each academic field.

Partnerships between the university and society, as well as international partnerships to handle various problems will be promoted. In particular, international partnerships with educational and research institutions etc. in Asian countries will be made even more substantial.

Outline of Research Results

This program conducted the following activities in line with the original research action plan.

(1) Accumulations and Thinking

Progress was made in the collection of generally hard-to-obtain organizational publications, etc. from patients’ associations and disabled persons’ organizations and making

them publicly available via the web. Also, book information and commentary from approximately 1,900 volumes pertaining to ars vivendi were added (approximately 9,100 at present). This program’s site receives approximately 11 million hits a year. Fifteen works authored or co-authored by faculty, PD, and graduate students were published. Also, issues 16-18 of the Report Issued by the Research Center

for *Ars Vivendi* edited by graduate students and visiting researchers at the Center and volumes four and five of the journal *Ars Vivendi* were published. Graduate students have made numerous submissions to the publications and have made their research findings available to the public. Also, *Ars Vivendi Journal*, a multilanguage electronic journal whose main language is English, was launched, and two issues were published. Information is disseminated via diverse media, such as issuing an e-mail magazine in Japanese, English, and Korean, and activity reports notifications etc. via mixi and twitter.

(2) Reorganization of Studies

Normative, Policy and Technological Issues of Communication for Deaf and Hard of Hearing People (Vol. 16, Report Issued by the Research Center for *Ars Vivendi*, July 2011) was published. Also, academic conference presentations, as well as industry-academic-government joint symposiums on e-book accessibility were held in collaboration with the “Integrated Research of Accessible Ebooks: Interfaces & Services” (Research Program of the Ritsumeikan Global Innovation Research Organization (R-GIRO)). Moreover, experiments on creating text data in libraries were conducted in collaboration with the “Library Accessibility Group” in the Institute of Human Sciences. Also, an international workshops was held in Korea and an interview/bibliographical essay with the creator of “EyeWriter” – a communication device created in open-source and is linked to art performances -- were published in volume five of *Ars Vivendi*.

(3) Cooperation and Construction

Immediately after the Great East Japan Earthquake on March 11, 2011, a specially created site pertaining to disabled persons and the disaster was established on this program’s

website and information was disseminated in English and Korean in addition to Japanese. Also, a series of projects related to the issue of disabled persons being affected by the disaster and their survival were implemented, and they were partially relayed via the internet. Presentations were also made at international conferences etc. At both the 2nd International Seminar on Disability Studies held in November, 2011, as well as the international symposium “Catastrophes and Justice,” which was sponsored by the Graduate School of Core Ethics and Frontier Sciences, which houses this program in March 2012, numerous faculty and graduate students affiliated with this program participated and had presentations. In addition, in the same month, *Together with Medical Devices --In Order to Live Outside of Institutions, Symposium Report "How Have You Survived the Disaster and Power Outages?: Inviting People with Intractable Diseases / People with Ventilators Living at Home in Fukushima etc.* (Volume 18, Report Issued by the Research Center for *Ars Vivendi*) was published. Also, partnerships with overseas educational and research institutions were developed, and research cooperation agreements were signed with the Korean Association of Disability Studies (Korea), the GyeongGi-Do Assistive Technology Research & Assistance Center (Korea) and Clark University (United States). In addition, preparations are underway to conclude a memorandum of agreement for Academic Year 2012 with Università degli Studi di Salerno (Italy) as well.

Regarding the implementation of “self-evaluation,” aside from internal evaluations by experts at the University, outside specialists deeply involved in *ars vivendi* such as Professor Arthur Frank and Professor Emeritus Chizuko Ueno, were invited, and an external evaluation was performed. The Program received the high evaluation at the evaluation. These evaluations were summarized as *Final Report by the Self-evaluation Committee*.



Ars Vivendi: Forms of Human Life and Survival

Disabilities, Aging, Illness, and Various Physical Differences



However, there are courses which people live though before they become a “patient” or a “person receiving assistance.”

The Art of Living

Focus on the settings in which people with disabilities, aging, illness, or various differences live. Seek out the actual manner and art they use to live with disabilities, aging, illness, and differences.

Ritsumeikan University Graduate School of Core Ethics and Frontier Sciences Graduate Students Learning at “Ars Vivendi”



We have established an organized educational and research system that was insufficient in existing humanities and social sciences research institutes.

Global COE Program

Global Center of Excellence for Education, Research and Development of Strategy on Disaster Mitigation of Cultural Heritage and Historic Cities

Graduate School of Science and Engineering
Professor **Takeyuki OKUBO**

Outline of Research Plan

This research expands and deepens the research target from The 21st Century Center Of Excellence Program, and considers cultural heritage in a unified and comprehensive manner with the surrounding historical environment, including artistic handicrafts and wide urban areas, to historical cities around the world. In addition, the following objectives will be attained through practical and widespread application of research findings the development and spread of an educational program toward the systemization of “Cultural Heritage Disaster Mitigation Studies:” 1) development of young researchers and practitioners who will be responsible for cultural heritage disaster mitigation, 2) research and development in advanced cultural heritage disaster mitigation technologies which as universal and widespread, and 3) international contributions in education and research on cultural heritage disaster mitigation.

(1) Creation and Implementation of an Educational System

In addition to providing an environment where students enrolled in the doctoral program can continue to concentrate on their research activities by promoting their employment as teaching assistants and providing all of them with research subsidies, working adult students will be provided re-education as practitioners which will make them job-ready specialists. Also, the Graduate School of Science and Engineering formally established the “Historical City Disaster Mitigation Course” (April 1, 2012), and is actively working on a “Educational Program for Cultural Heritage Disaster Mitigation Studies” that non-University students may enroll in as well. In addition, in a joint effort with the “Digital Humanities Center for Japanese Arts and Cultures” preparations are underway toward the establishment of a new activity base in anticipation of the completion of this program.

(2) Promotion of Research Activity

This project continues to engage the following four research topics: 1) Value of Cultural Heritage and Vulnerability, 2) Disasters in History, 3) Disaster Mitigation Technology, and 4) Disaster Mitigation Planning and Policy. By aggregating

the findings from these areas and recreating them in a generally easy-to-understand manner, a universal “Cultural Heritage Disaster Countermeasures Toolkit (Handbook)” will be created. Research which develops and creates a comprehensive handbook which can also be utilized overseas has also raised the hopes of international organizations such as UNESCO, who expects that the findings of this research can lead to global standards in cultural heritage disaster mitigation.

(3) International Training/Establishment of an Educational Network

Two international training programs will be continued. The first to be continued is the “International Training Course for Cultural Heritage Disaster Mitigation”, which is part of the official UNESCO Chair Program, and preparations are underway to implement it as a joint educational venture with World Heritage Sites as the fieldwork site. The second is to develop the JICA International Specialist Training Program, and to continue it with the additional perspective of tourism disaster mitigation. By continuing training for young administrative staff members and researchers, etc. from developing countries, this program will contribute to international society in the area of human resources development as well.

(4) Constructing an International Research Network

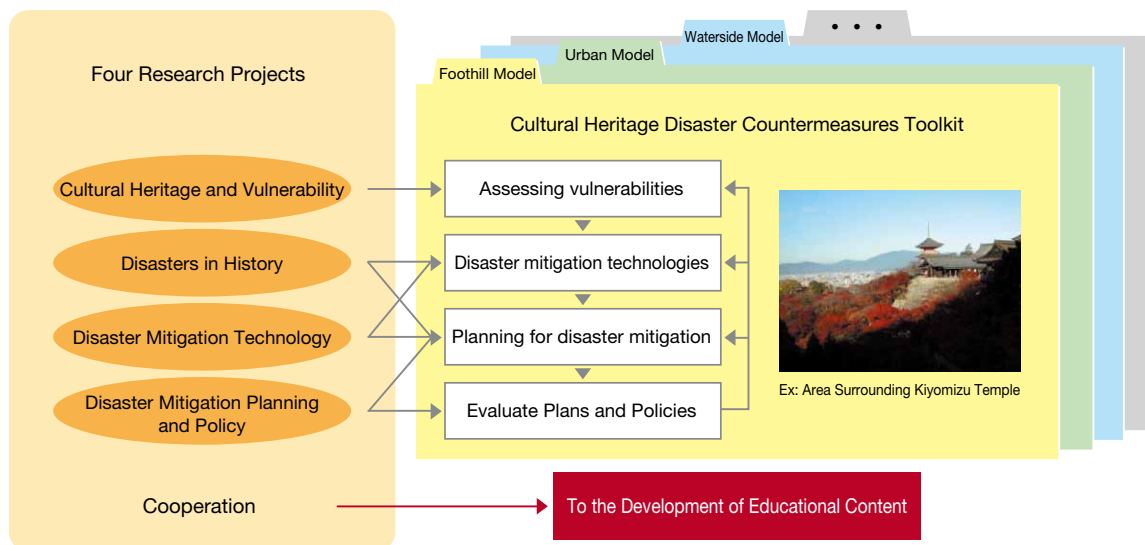
With the support of UNESCO, this project has been participating in “Forum UNESCO University and Heritage (FUUH)” since 2010, and will continue to develop even vaster networks of researchers and practitioners. As a result of promoting the establishment of the International Committee on Risk Preparedness (ICORP) in the International Council on Monuments and Sites (ICOMOS), the NGO responsible for selecting UNESCO World Heritage Sites, a program member related to this hub was elected chairman, and even more structural developments and renewals will be required in the future.

Outline of Research Results

In order to establish the foundations of this project, the following were carried out within the Advanced Research Programs at Ritsumeikan University “Program for Core-to-Core Research” budget. As part of spreading activities, public information, and the social education of young researchers, posters and flyers pertaining to the “Cultural Heritage Disaster Mitigation Idea Competition” were printed, along with the creation of a homepage, requests for judges, and the publication of books and reports. As management support for the “Research Center for Disaster Mitigation of Urban Cultural Heritage,” which is the base activity, a homepage for disseminating information was created, materials introducing researchers were created, and public information activities for the Disaster Mitigation Map Contest, etc. were conducted. As a part of promoting international activity and contributing to society, along with continuing the UNESCO Chair training program “Cultural Heritage and Disaster Mitigation,” advisors were invited from international organizations such as UNESCO to prepare training textbooks. Travel funds for promoting joint research with overseas partner hubs, and a Water Spreading System (WSS), one of the advanced technological developments which sprays water into the street to protect wooden cultural sites from spreading flames were developed.

Specifically, the ongoing endeavor “Cultural Heritage Disaster Mitigation Idea Competition” was implemented and managed, and many entries were received from young people nationwide.

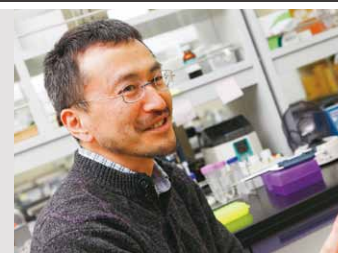
The projects were summarized into catalog so that these valuable findings can be widely given back to society, and the third general book was published. Also, through management support and information dissemination on the “Research Center for the Mitigation of Urban Cultural Heritage,” the foundational activity for this project, Ritsumeikan University’s establishment and promotion of Cultural Heritage Disaster Mitigation Studies was promoted to the relevant overseas and domestic agencies, and international society. Furthermore, there was ongoing holding and managing of the UNESCO Chair international training program, which is the first in the world to handle cultural heritage and historical city risk management. The program in 2011 welcomed participants from eight countries, including new participants from Africa, and by including on-the-scenes training at sites affected by the Great East Japan Earthquake, it was possible to obtain information regarding the actual conditions at the disaster-stricken areas during seminars. Also, as an example of advanced research and development, experiments were performed on fire-spreading suppression systems which increase the fireproofing of city areas with traditional wooden structures as they are by automatically spraying water from the street side at the outer wooden walls of houses, such as the traditional “machi-ya” houses in Kyoto. Through these efforts, Ritsumeikan University is showing its presence in this field to the world.



Develop a “Cultural Heritage Disaster Countermeasures Toolkit” -> Support Commercialization

Program for the First-Phase R-GIRO Research (Specific Topics for Sustainable Society)

Establishment of Cell Lines for Fish and Shellfish Endemic to Lake Biwa and their Application as Biosensors

College of Pharmaceutical Sciences
Professor **Tatsuyuki TAKADA**

Outline of Research Goals/Plan

Lake Biwa is the third-most ancient lake in the world, following Lake Baikal and Lake Tanganyika, and numerous valuable endemic species have been observed there, but in recent years, due to environmental change, their numbers are rapidly decreasing. In particular, the endemic species in Lake Biwa have formed a unique food culture, as they have been used for traditional dishes such as *funazushi* and *tsukudani*, in addition to biological importance. Namely, the endemic species in Lake Biwa are valuable biological resources for both lifestyle and culture, and their loss will be directly linked to the loss of local culture. Therefore, the preservation of endemic species in Lake Biwa is an extremely important issue from not just the standpoint of biological diversity, but also of that of preserving traditional culture.

This study establishes cell lines from the testes, ovaries, and fertilized eggs of these endemic species in Lake Biwa, stores cell lines that could be reconstructed to create the original species in the future for preserving biological resources. While these established cell lines will be used

as biosensors to evaluate water quality for the endemic species. Furthermore, these cell lines also contribute to develop cell biology such as elucidation of the mechanism for sex determination in endemic species.

Regarding the biosensors, first a biosensor system using mouse and monkey ES cells will be constructed to identify chemicals which influence cell differentiation, and to search for useful natural compounds. Afterward, biosensors will be constructed with the established cell lines originating in the fish endemic to Lake Biwa. This is a tailor-made biosensor system which enables to validate the adverse effect directly on the endemic species.

The primary aim of this project is the preservation of the endemic species in Lake Biwa using state-of-the-art stem cell biology, and try to connect basic research to regional culture through scientific accomplishment (preservation of endemic species and water quality management using biosensors). The goal of this project is to balance and harmonize biotechnology and the humanities.

Status of Research Plan Progress

(1) Establishing Cellular Strains from Fish and Shellfish Endemic to Lake Biwa

We focused on the *honmoroko* (*Gnathopogon caerulescens*, Eng: *willow gudgeon*) as the endemic species of Lake Biwa for this project. Using the gonads (testes, ovaries) and fertilized embryos of the *honmoroko*, we tried to find culture conditions to maintain cell proliferation using several growth factors and we succeeded to establish cell lines derived from testes, ovaries, and fertilized eggs (patent pending). Because *honmoroko* reproduce seasonally, we tried to establish cell lines from the gonads in the spawning season and non-spawning season. We were able to establish many cell lines with a high reproducibility, and ten cell lines were established from testes, four from

ovaries, and one from fertilized embryos. We found that these cell lines were able to preserve in liquid nitrogen for an extended period of time. Furthermore, gene expression analysis confirmed that these cell lines express testis and ovary marker genes. However, the expression of germ cell markers was weak, and they were considered to be derived from sertoli cells, granulosa cells, or theca cells. Interestingly, these cell lines expressed various steroid hormone receptor genes, which suggest the possibility they could be used as sensors for steroid hormones in the water.

Currently, we are trying to establish germ cell lines using these cell lines as feeder cells.

(2) Construction of Biosensors

Vectors which express fluorescent proteins (Venus) under the control of germ cells, fat cells and osteoblast were created, and were introduced into mouse ES cells. In addition, germ cell specific reporter was constructed using monkey ES cells, and was confirmed to be functional as biosensors. Of particular interest, we found, for the first time, that Bisphenol A (BPA), considered to be an endocrine disruptor, up-regulate germ cell markers (*Vasa*, *Dazl*, *Dmrt1*, *Stra8*, *Dmc1*), modulate retinoic acid signaling and possibly feminize the gonads*.

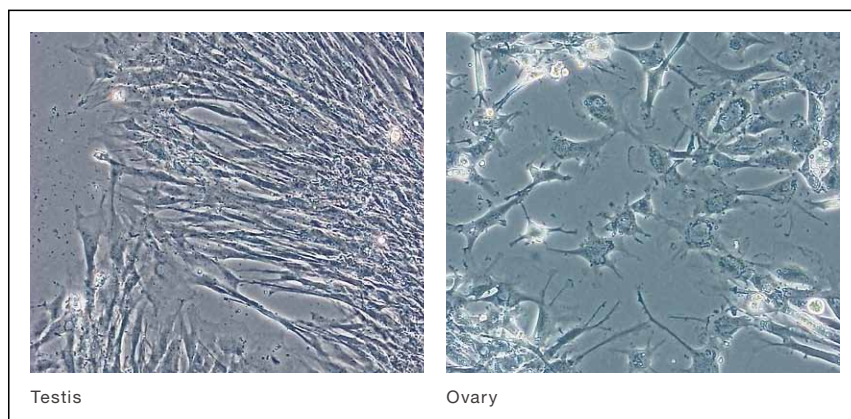
Using these established reporter ES cell lines, we are trying to screen natural compounds which promote or inhibit germ cell differentiation from actinomycete library. During the course of this study, we also developed a

method to analyze DNA methylation using small numbers of cells (about 100 cells) (patent pending).

As we mentioned, gonad-derived cell lines we established expressed steroid hormone receptor genes, suggesting that they can be applicable as environmental hormone sensors. Therefore, we introduced vectors which express luciferase in the presence of estrogen, androgen, and glucocorticoid into the cell line and succeeded to establish biosensors which can detect these hormones.

Furthermore, we are currently attempting to express human receptors in these fish cell lines with a strong emphasis on drug discovery.

*Aoki T., Takada, T.
Bisphenol A modulates germ cell differentiation and retinoic acid signaling in mouse ES cells. *Reprod. Toxicol.* In press



Established cell lines from *honmoroko* (*Gnathopogon caeruleus*)

Industry-Academia-Government Collaboration Activities

Endeavors Related to Industry-Academia-Government Collaboration Activities

Ritsumeikan University founded the “Biwako-Kusatsu Campus” (henceforth, “BKC”) in order to relocate and expand the College of Science and Engineering in 1994. In conjunction with this, the University established a “Liaison Office,” which served as the office for industry-academia-government collaboration activities, in 1995, and has actively developed industry-academia-government collaboration activities ahead of other universities nationwide. As a result, in 2005 and 2006, Ritsumeikan was a leading figure in the Ministry of Economy, Trade and Industry’s “University Activity Evaluation Method Survey Project (an evaluation of an industry-academia collaboration office at a university, etc. by industry),” where it ranked first place for two years in a row, receiving high

praise from society.

Regarding industry-academia-government collaboration activities, for the Phase II Plan basic goals, the University stated the following as its goal: “through industry-academic-government collaboration activities, promote commissioned and joint research, etc. with national and local government agencies and corporations, and contribute to society by giving research findings of a broad spectrum back to society.” Ritsumeikan University is enhancing its basic foundations to develop industry-academia-government collaboration activities in an organized manner, and aspires to give research results created from these foundations back to society.

Research Introduction

Development of an “In-Situ Opto-Bio Bioremediation System with Environmental Quantification and Optic Technology”

Ritsumeikan University, Kumagai Gumi Co., Ltd.,
Seiwa Electric Manufacturing Co., Ltd., NIKKO Co., Ltd., YBM, Co. Ltd.

College of Life Sciences
Professor **Motoki KUBO**



Case Study Outline

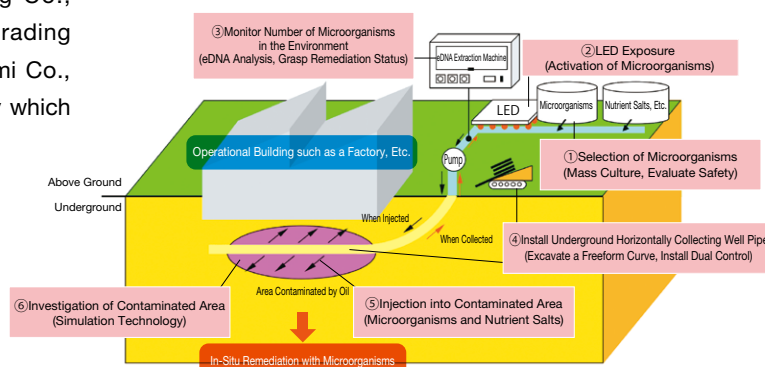
New Bioremediation system for oil-contaminated soil beneath a building without tearing down the building, but by injecting microorganisms, was developed by an industry-academia-government collaboration team.

Ritsumeikan University isolated bacteria to effectively degrade hard-to-degrade hydrocarbons such as cycloalkane, and established technology for using it. Also, in addition to developing technology which quickly extracts environmental DNA (eDNA) from the soil and quantifies the number of bacteria (approximately two hours), technology was created which can use the extracted eDNA to quantify only oil-degrading bacteria. Seiwa Electric Manufacturing Co., Ltd. established technology to activate the oil-degrading bacteria by shining a light (LED) on it. Kumagai Gumi Co., Ltd. established induction-type free drilling technology which

can accurately reach the contaminated area in the ground, and dual-pipe type injector technology which makes precise injection of microorganisms into the ground possible. In addition, “geo-catheter,” a new soil sampling method which uses horizontal boring, was developed.

By fusing university-created biotechnology with optical and civil engineering technology under the auspices of a subsidy from the New Energy and Industrial Technology Development Corporation (NEDO), this case study can be said to be an outstanding example of a practical application of an in-situ oil contaminated soil remediation system.

An environmental fixed quantity, the original position opto bio-soil-ized system by opto-electronics



Research Organizations, Research Institutes and Research Centers

Ritsumeikan University's research activities are promoted with its four research organizations, Kinugasa Research Organization, BKC Research Organization of Social Science, Research Organization of Science and Technology, and

Ritsumeikan Global Innovation Research Organization (R-GIRO) , as well as the research organizations under the four, as the basis of the activities.

Ritsumeikan Global Innovation Research Organization (R-GIRO)

R-GIRO is a research organization under the direct control of the University President, and was established in 2008 with the goal of “forming a research hub specifically for policy-driven research topics” and “strengthening the development of young researchers who will lead the next generation.” The organization’s goal is to contribute to the next generation of society by producing valuable research findings and actively disseminating them through the promotion of interdisciplinary research activity which aims to integrate the natural science fields with those in the humanities and social sciences toward the realization of a symbiotic society that the 21st century demands.

Kinugasa Research Organization

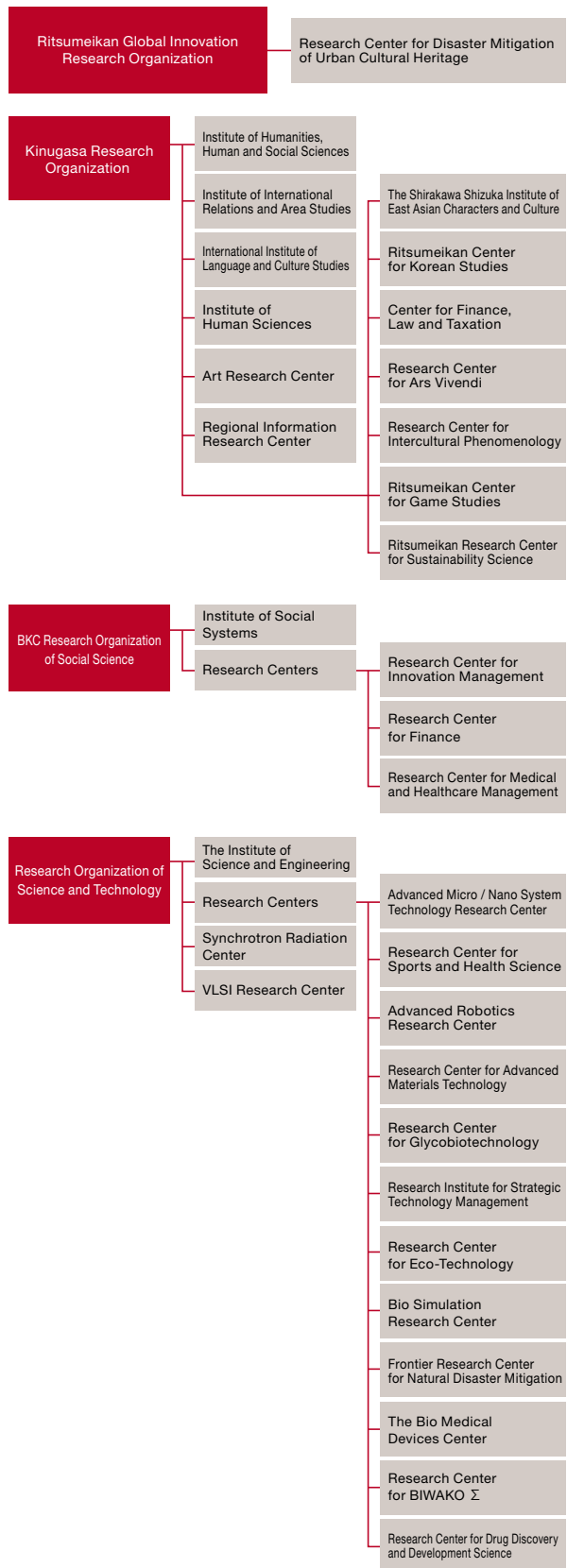
Kinugasa Research Organization was founded in 1998 and it supports research activity as a research organization which manages the research institutes and research centers. The organization’s goal is to contribute to human welfare and social progress under the four principles of “autonomy,” “democracy,” “openness,” and “peaceful use”.

BKC Research Organization of Social Science

Research Organization of Social Science (BKC) was founded in 1998 in order to promote research activity in business-related fields, in conjunction with the relocation of the College of Economics and the College of Business Administration to BKC. Its goal is to advance research with greater social connectivity by promoting research which fuses economics, management and technology.

Research Organization of Science and Technology

Research Organization of Science and Technology was established in 1994 as the Research Organization of Science and Engineering (changed to its present name in 2011) to contribute to the development of science and technology and local society. The organization’s goal is to contribute to the development of science and technology and contribute to local society through joint research in industry-academia-government partnerships.



(1) No. of Faculty and Research Scholars (as of May 1, 2011)

(unit: person)

		Position	Suzaku Campus	Kinugasa Campus	Biwako-Kusatsu Campus	Total
Full-time	Sennin	Professor	23	270	273	566
		Associate Professor	5	103	92	200
	Fixed Term Employment	"Ninkisei" Professor	5	11	6	22
		"Ninkisei" Associate Professor	0	21	8	29
		"Ninkisei" Lecturer	0	6	12	18
		Assistant Professor	1	10	70	81
		"Tokubetsu Keiyaku" Professor	20	9	1	30
		"Tokubetsu Keiyaku" Associate Professor	1	3	0	4
		"Tokubetsu Ninyo" Professor	0	38	20	58
		"Tokumei" Professor	2	2	3	7
		"Tokubetsu Shohei" Professor	1	12	16	29
		"Tokubetsu Shohei" Associate Professor	0	3	3	6
	"Shokutaku" Full-Time Lecturer	0	108	7	115	
	Part-time	Visiting Professor	22	51	67	140
Visiting Associate Professor		1	0	0	1	
Chair Professor		0	2	33	35	
"Tokubetsu Shohei" Professor		0	9	15	24	
"Tokubetsu Shohei" Associate Professor		0	2	0	2	
Part-time Lecturer		17	557	302	876	
Research Scholar	Postdoctoral Fellow	0	42	60	102	
	Research Assistant	0	30	20	50	
	Research Associate	0	0	40	40	
Total			98	1,289	1,048	2,435

● Suzaku Campus

School of Law, Graduate School of Management, Graduate School of Public Policy

● Kinugasa Campus

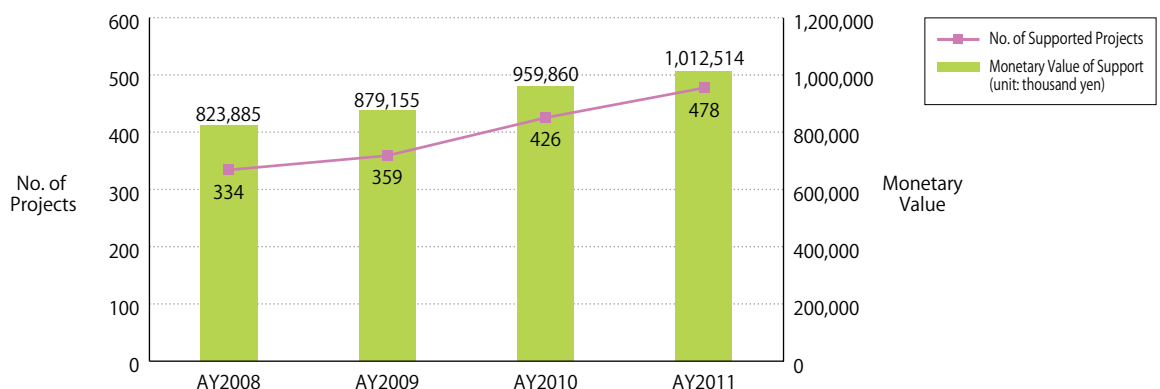
College of Law, College of Social Sciences, College of Letters, College of International Relations, College of Policy Science, College of Image Arts and Sciences, Graduate School of Science for Human Services, Graduate School of Core Ethics and Frontier Sciences, Graduate School of Language Education and Information Science, Ritsumeikan-Global Innovation Research Organization (Humanities and Social Sciences), Kinugasa Research Organization, Others

● Biwako-Kusatsu Campus

College of Economics, College of Business Administration, College of Science and Engineering, College of Information Science and Engineering, College of Pharmaceutical Sciences, College of Life Sciences, College of Sport and Health Science, Graduate School of Technology Management, Ritsumeikan Global Innovation Research Organization (Natural Sciences), Research Organization of Science and Technology, BKC Research Organization of Social Science

(2) Monetary Amount and No. of Projects Supported by Grants-in-Aid for Scientific Research (Figures are for March 31 each year)

	AY2008	AY2009	AY2010	AY2011
No. of Supported Projects	334	359	426	478
Monetary Value of Support (unit: thousand yen)	823,885	879,155	959,860	1,012,514



(3) Year-on-year Comparison of the No. of Projects Selected for Grants-in-Aid for Scientific Research (Figures are as of the preliminary approval stage for the first grant of each year.)

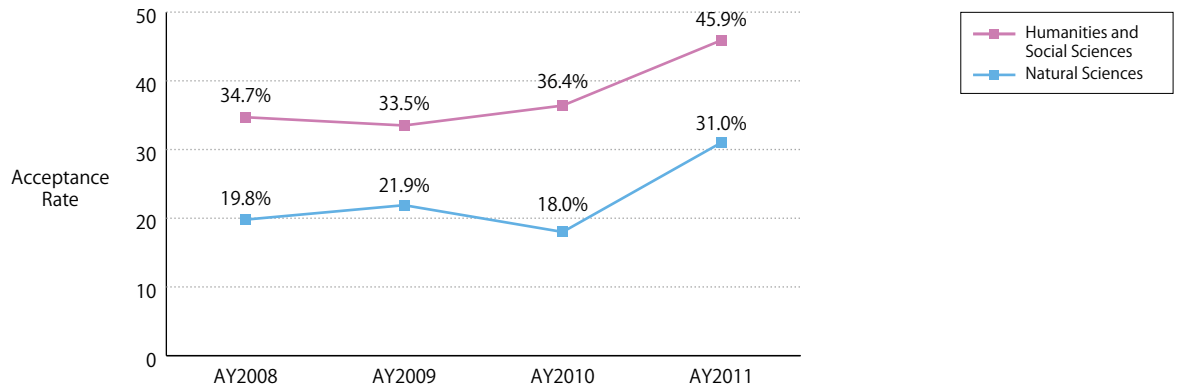
		AY2008	AY2009	AY2010	AY2011
No. of Applications		392	404	417	472
Grant awarded (for new projects)	No. of Projects	106	108	107	174
	Amount (unit: thousand yen)	286,949	278,740	290,720	465,800
Grant awarded (for continuing projects)	No. of Projects	157	175	234	237
	Amount (unit: thousand yen)	390,469	434,069	557,635	486,393
Total	No. of Projects	263	283	341	411
	Amount (unit: thousand yen)	677,418	712,809	848,355	952,193

(4) Acceptance Rate of Applications for Grants-in-Aid for Scientific Research and Project-Faculty Ratio (Figures are as of the preliminary approval stage for the first grant of each year.)

① Changes in the Acceptance Rate for Grants-in-Aid for Scientific Research

	AY2008			AY2009			AY2010			AY2011		
	Applications	Accepted Projects	Acceptance Rate	Applications	Accepted Projects	Acceptance Rate	Applications	Accepted Projects	Acceptance Rate	Applications	Accepted Projects	Acceptance Rate
Humanities and Social Sciences	190	66	34.7%	167	56	33.5%	173	63	36.4%	185	85	45.9%
Natural Sciences	202	40	19.8%	237	52	21.9%	244	44	18.0%	287	89	31.0%

Acceptance rate = the No. of accepted projects / the No. of applications x 100

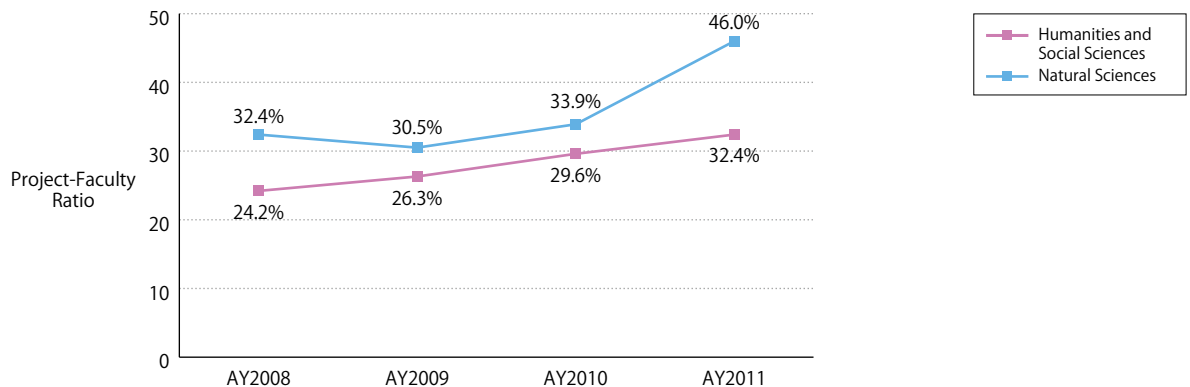


② Changes in the Project-Faculty Ratio for Grants-in-Aid for Scientific Research

	AY2008	AY2009	AY2010	AY2011
Humanities and Social Sciences	24.2%	26.3%	29.6%	32.4%
Natural Sciences	32.4%	30.5%	33.9%	46.0%

Project-Faculty Ratio = No. of accepted projects / No. of faculty x 100

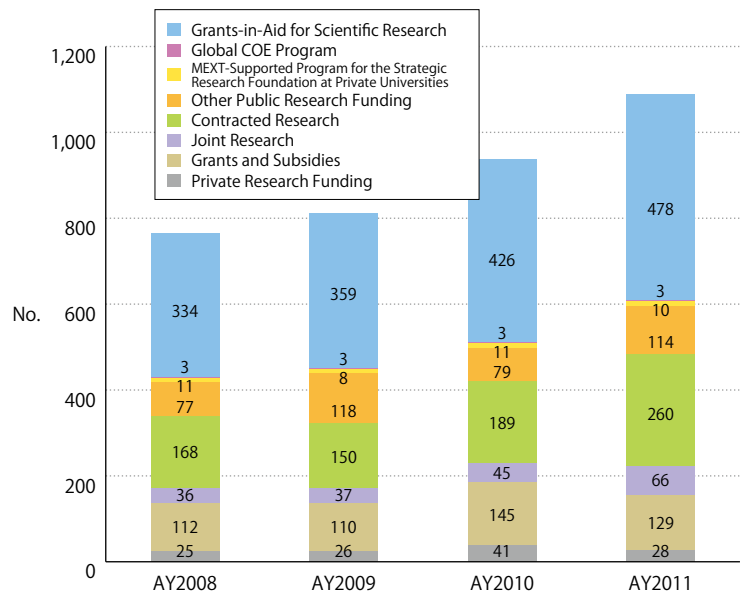
The Project-Faculty Ratio is calculated by dividing the No. of accepted projects by the No. of faculty at Ritsumeikan University.



(5) External Research Funding

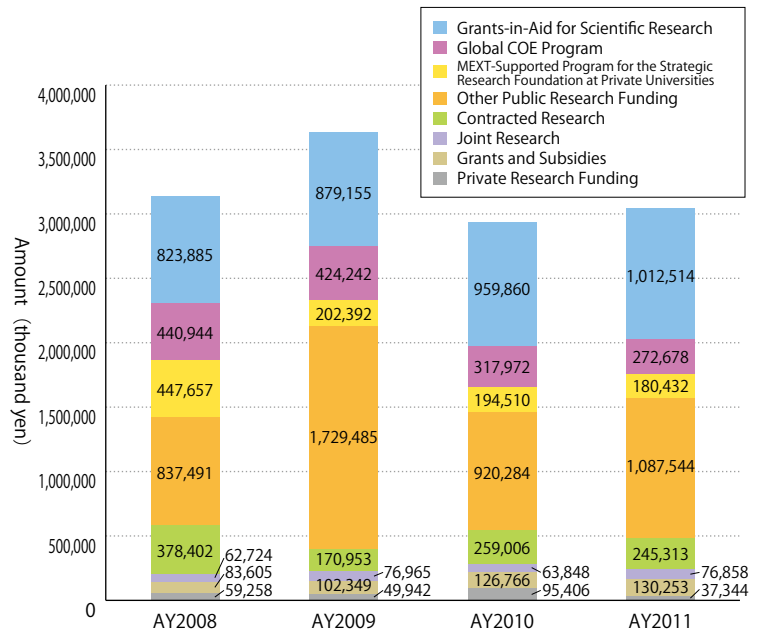
① No. of Projects by Funding Source

	AY2008	AY2009	AY2010	AY2011
Grants-in-Aid for Scientific Research	334	359	426	478
Global COE Program	3	3	3	3
MEXT-Supported Program for the Strategic Research Foundation at Private Universities	11	8	11	10
Other Public Research Funding	77	118	79	114
Contracted Research	168	150	189	260
Joint Research	36	37	45	66
Grants and Subsidies	112	110	145	129
Private Research Funding	25	26	41	28
Total	766	811	939	1,088



② Monetary Amount by Funding Source (unit: thousand yen)

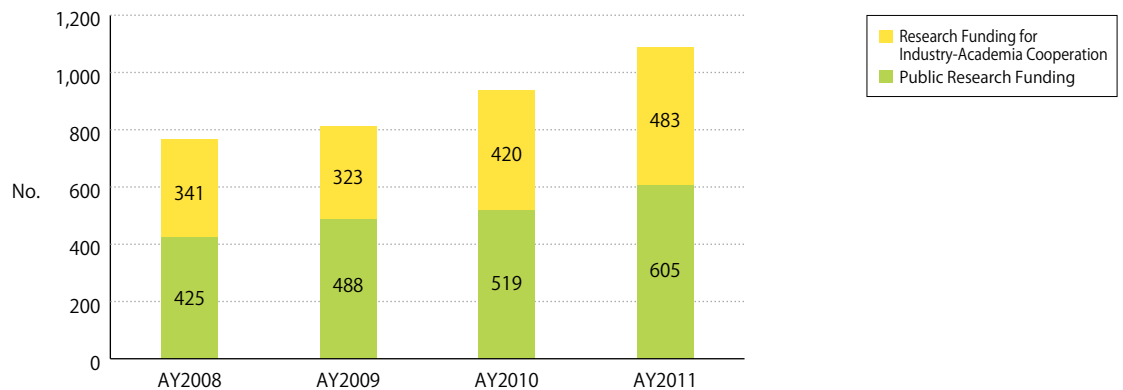
	AY2008	AY2009	AY2010	AY2011
Grants-in-Aid for Scientific Research	823,885	879,155	959,860	1,012,514
Global COE Program	440,944	424,242	317,972	272,678
MEXT-Supported Program for the Strategic Research Foundation at Private Universities	447,657	202,392	194,510	180,432
Other Public Research Funding	837,491	1,729,485	920,284	1,087,544
Contracted Research	378,402	170,953	259,006	245,313
Joint Research	62,724	76,965	63,848	76,858
Grants and Subsidies	83,605	102,349	126,766	130,253
Private Research Funding	59,258	49,942	95,406	37,344
Total	3,133,966	3,635,483	2,937,652	3,042,936



③ No. of Projects by Funding Source (research funding for industry-academia cooperation / public research funding) (No. of projects)

	AY2008	AY2009	AY2010	AY2011
Research Funding for Industry-Academia Cooperation	341	323	420	483
Public Research Funding	425	488	519	605
Total	766	811	939	1,088

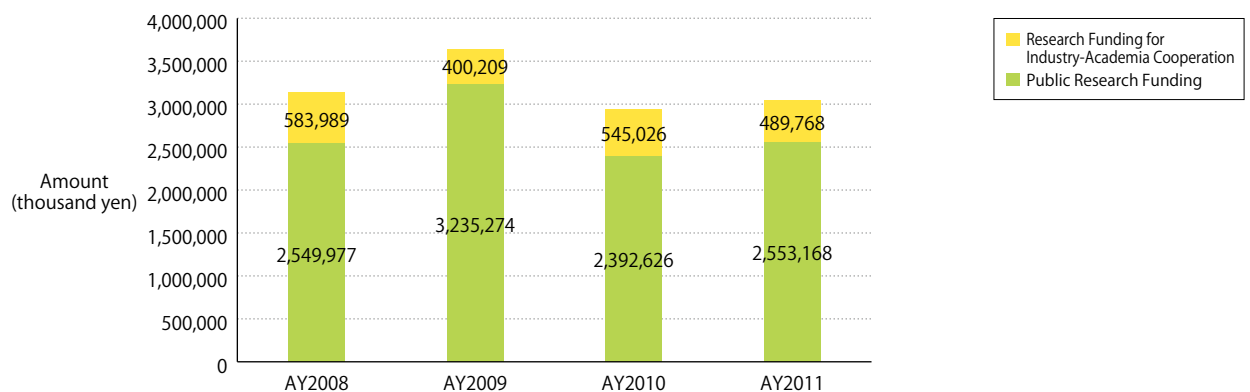
Research funding for industry-academia cooperation=contracted research, joint research, grants and subsidies, private funding subsidies
 Public research funding=Grants-in-Aid for Scientific Research, Global COE Program, MEXT-Supported Program for the Strategic Research Foundation at Private Universities, other public research funding (government subsidies, contracted research, joint research, etc.)



④ Monetary Amount by Funding Source (research funding for industry-academia cooperation / public research funding) (unit: thousand yen)

	AY2008	AY2009	AY2010	AY2011
Research Funding for Industry-Academia Cooperation	583,989	400,209	545,026	489,768
Public Research Funding	2,549,977	3,235,274	2,392,626	2,553,168
Total	3,133,966	3,635,483	2,937,652	3,042,936

Research funding for industry-academia cooperation=contracted research, joint research, grants and subsidies, private funding subsidies
 Public research funding=Grants-in-Aid for Scientific Research, Global COE Program, MEXT-Supported Program for the Strategic Research Foundation at Private Universities, other public research funding (government subsidies, contracted research, joint research, etc.)



(6) No. of Applications / No. of Acceptance/Acceptance Rate / Amount of Advanced Research Programs at Ritsumeikan University (Basic Research) AY2011

	No. of Applications	No. of Acceptance	Acceptance Rate	Amount (unit: thousand yen)
Program to Support General Research Activities (Kiban-kenkyu)	87	45	51.7%	39,500
Program for Application of the Grants-in-Aid for Scientific Research (KAKENHI)	37	37	100.0%	21,000
Program for Research of Young Scientists (Wakate-kenkyu)	133	63	47.4%	39,594
Program for Post Doctoral Fellowship(for new projects)	59	10	16.9%	46,653
Program for Post Doctoral Fellowship(for continuing projects)	16	11	68.8%	52,527
Program for Promotion of Academic Publication	28	13	46.4%	12,404
Program for Promotion of International Research	56	42	75.0%	33,665

(7) No. of Applications / No. of Acceptance / Acceptance Rate / Amount of Advanced Research Programs at Ritsumeikan University (Research Hubs) AY2011

	No. of Acceptance	Amount (unit: thousand yen)
Program for Research Institute Mission	23	29,565
Program for Development of Center of Excellence (Seisakuteki jutten kenkyu)	2	8,500
Program for Core-to-Core Research	3	47,000
Program for the First-Phase R-GIRO Research (Specific Topics for Sustainable Society)(for new projects)	1	10,000
Program for the First-Phase R-GIRO Research (Specific Topics for Sustainable Society)(for continuing projects)	32	261,000

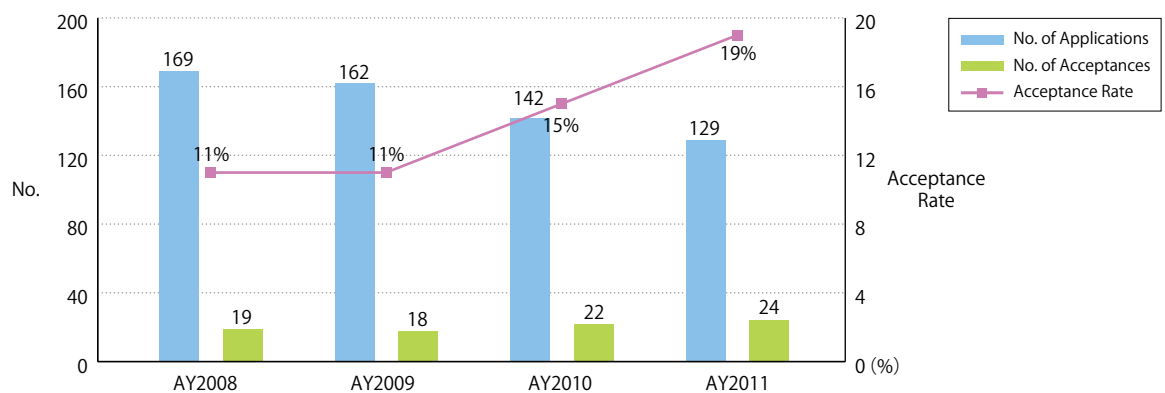
(8) Other internal research grants AY2011

	No. of grants	Amount (unit: thousand yen)
Program for Overseas Travel Support	44	2,921
Operational Grant for Academic Conferences	15	1,025
Individual Research Allowance (Material Allowance)	1,114	281,225
Individual Research Allowance (Travel Allowance)	992	100,744

(9) No. of Applications / No. of Acceptances / Acceptance Rate of Research Fellowships for Young Scientists

(unit: person)

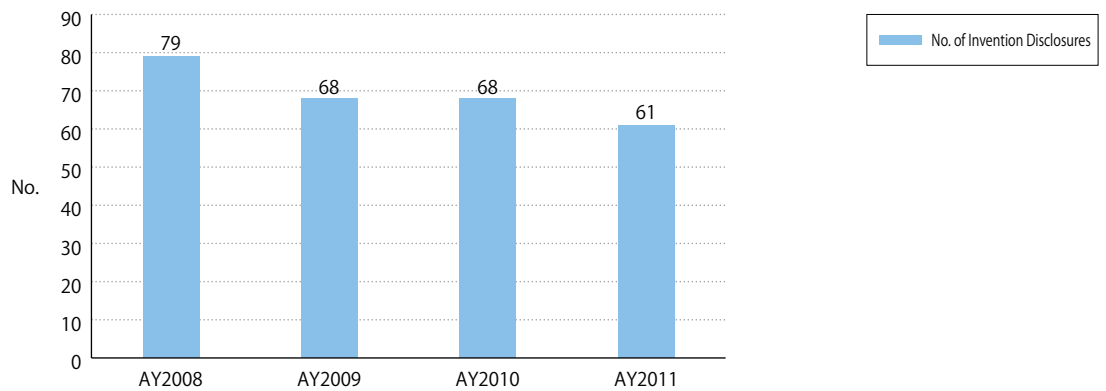
	AY2008	AY2009	AY2010	AY2011
No. of Applications	169	162	142	129
No. of Acceptances	19	18	22	24
Acceptance Rate	11%	11%	15%	19%

**Research Fellowships for Young Scientists:**

In view of the growing need to foster young researchers who will play an important role in future scientific research activities, JSPS provides a special program under which fellowships are granted to 1) young Japanese postdoctoral researchers who conduct research activities at Japanese universities or research institutions on a non-employment basis and to 2) graduate students who conduct research in Japanese university doctoral programs.

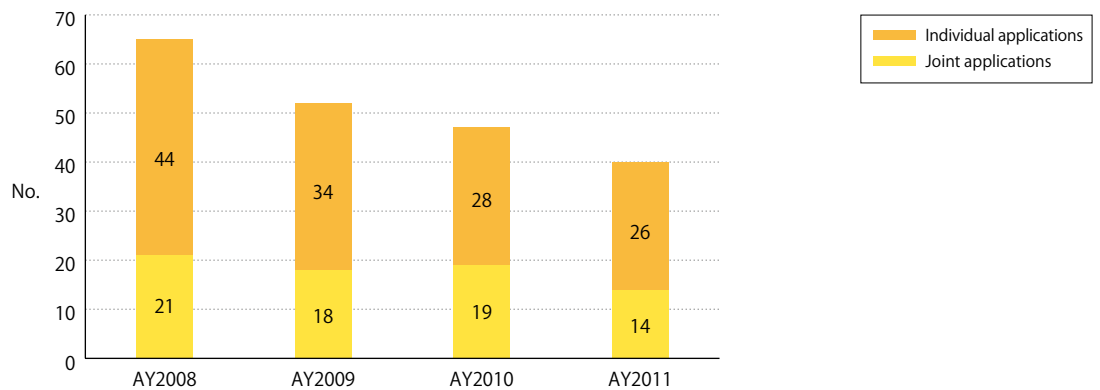
(10) No. of Invention Disclosures

	AY2008	AY2009	AY2010	AY2011
No. of Invention Disclosures	79	68	68	61



(11) No. of Domestic Patent Applications

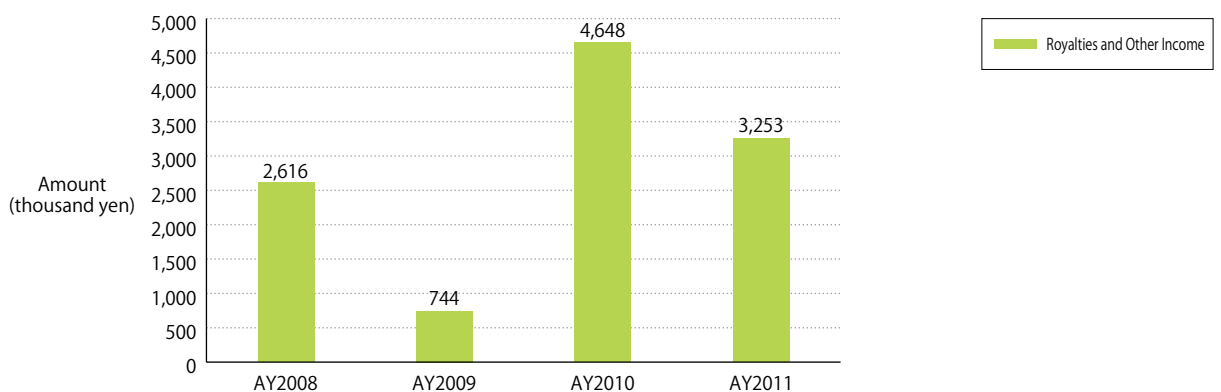
	AY2008	AY2009	AY2010	AY2011
Individual applications	21	18	19	14
Joint applications	44	34	28	26
Total	65	52	47	40



(12) Royalties and Other Income

(unit: thousand yen)

	AY2008	AY2009	AY2010	AY2011
Royalties and Other Income	2,616	744	4,648	3,253





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