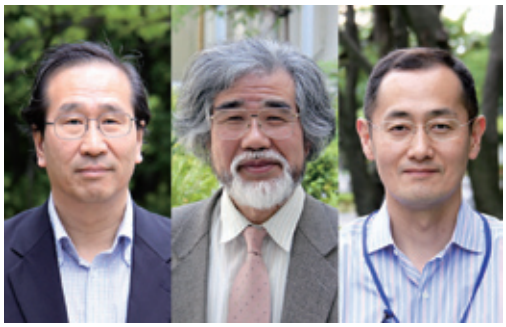
WPI: Institute for Integrated Cell-Material Sciences (iCeMS)

Launched in 2007 by the MEXT* to create globally visible research centers, the **World Premier International Research Center (WPI) Initiative** seeks to 1) advance leading edge research, 2) create new inter-disciplinary domains, 3) establish truly international research environments, and 4) reform existing research organizations. The iCeMS is one of six WPI centers. Its founding director is Prof. **Norio Nakatsuji,** Japan's pioneer in the establishment and distribution of human ES cell lines, and a leader in ES/iPS cell-based drug discovery.



From left: Deputy Director **Susumu Kitagawa,** Director **Norio Nakatsuji,** CiRA Director and iCeMS Professor **Shinya Yamanaka**

Creating new cross-disciplinary fields through integration of the cell and material sciences

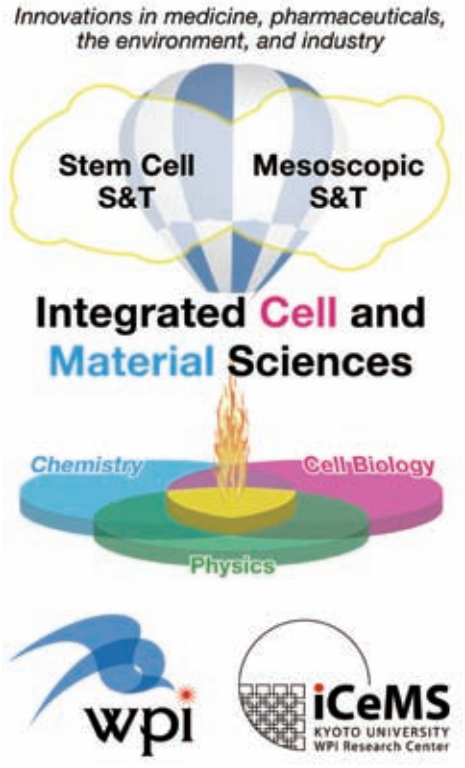
Investigating the control mechanisms of multimolecular structures within cells and artificial materials, the iCeMS pioneers the development of *stem cell science and technology*, and *mesoscopic science and technology*. These are anticipated to lead to innovations in medicine, pharmaceuticals, the environment, and industry.

Stem cell science and technology include:

- reprogramming with chemical compounds for iPS cell derivation
- chemical probes for stem cell research
- control of ES/iPS cell growth and differentiation with chemicals and materials
- creation and applications of stem cell-derived model cells in medicine and drug discovery

Mesoscopic science and technology include:

- imaging and probing mesoscopic complexes in living cells
- production of functional mesoscopic materials (e.g., porous coordination polymers)
- integration of mesoscopic materials and living cells
- modeling, simulation, and physics theories of mesoscopic events in materials and living cells



www.icems.kyoto-u.ac.jp

*Japanese Ministry of Education, Culture, Sports, Science and Technology

Center for iPS Cell Research and Application (CiRA)

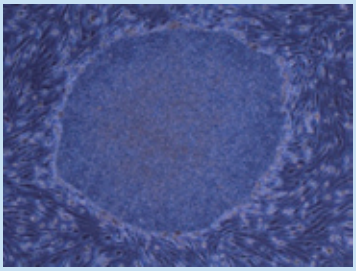
The Center for iPS Cell Research and Application (CiRA) was established in April 2010 as the world's first institute focusing on induced pluripotent stem cells or iPS cells. Professor Shinya Yamanaka, who pioneered the research field of iPS cell technology, leads the institute as director. Equipped with a cell processing facility and laboratory animal research facilities, CiRA is comprised of four research departments - Reprogrannig Sceience, Cell Growth and Differentiation, Clinical Application and Regulatory Science and 26 principal investigators work here to realize medical and pharmaceutical applications using iPS cells.

Director
Shinya Yamanaka

iPS cells can be generated by the introduction of a few genes into human somatic cells, such as those taken from skins and blood, and culturing them for a few weeks. Similar to embryonic stem cells, iPS cells have the ability to differentiate into any type of cell in the body, including neurons, cardiac muscle cells and liver cells. iPS cell-derived functional cells are expected to be used for toxicological studies, in vitro drug screening and regenerative medicine. For more information about CiRA, please visit our website.
www.cira.kyoto-u.ac.jp/e/

CiRA's goals over the decade

- Establishing basic technologies and securing intellectual properties.
- Developing new drugs by using patient-derived iPS cells.
- Establishing an iPS cell bank for use in regenerative medicine.
- Conducting preclinical and clinical studies on a few diseases.



Human iPS cells

CiRA's intellectual property

CiRA's Legal Affairs and IP Office plays a central role in the management of patents associated with iPS cell technologies at Kyoto University and works closely with iPS Academia Japan Inc., which is authorized to license the use of the iPS cell patents. Kyoto University has obtained 3 patents in Japan, 1 patent in Europe and 1 patent in the U.S.

Global COE Programs: 13 Centers of Excellence

The Global COE (Centers of Excellence) is a program with an aim to support quality research and education centers of the world's highest order. 13 projects have been selected from the wide range of scientific fields at Kyoto University, and are supported by the MEXT. These are the projects that have been chosen from among hundreds that were established by the previous 21st Century COE program, and continue to contribute to the world's knowledge bank.

www.kyoto-u.ac.jp/en/research/capital/global_coe/global.htm

Category : Life sciences (Since 2007)
Title : **Formation of a strategic base for biodiversity and evolutionary research: from genome to ecosystem**
Leader : Professor Kiyokazu Agata, Graduate School of Science
URL : gcoe.biol.sci.kyoto-u.ac.jp/gcoe

Category : Chemistry, material sciences (Since 2007)
Title : **International Center for Integrated Research and Advanced Education in Materials Science**
Leader : Professor Mitsuo Sawamoto, Graduate School of Engineering
URL : www.mtl.kyoto-u.ac.jp/gcoe/E

Category : Information sciences, electrical and electronic sciences (Since 2007)
Title : **Informatics Education and Research Center for Knowledge-Circulating Society**
Leader : Professor Katsumi Tanaka, Graduate School of Informatics
URL : www.i.kyoto-u.ac.jp/gcoe

Category : Information sciences, electrical and electronic sciences (Since 2007)
Title : **Center of Excellence for Education and Research on Photonics and Electronics Science and Engineering**
Leader : Professor Susumu Noda, Graduate School of Engineering
URL : www.kuee.kyoto-u.ac.jp/gcoe/eng

Category : Humanities (Since 2007)
Title : **Revitalizing Education for Dynamic Hearts and Minds**
Leader : Professor Masuo Koyasu, Graduate School of Education
URL : www.educ.kyoto-u.ac.jp/gcoe/en

Category : Interdisciplinary and combined fields (Since 2007)
Title : **In Search of Sustainable Humanosphere in Asia and Africa**
Leader : Professor Kaoru Sugihara, Center for Southeast Asian Studies
URL : www.humanosphere.cseas.kyoto-u.ac.jp/en

Category: Medical sciences (Since 2008)
Title : **Center for Frontier Medicine**
Leader : Professor Syu Narumiya,
Graduate School of Medicine
URL : www.med.kyoto-u.ac.jp/GCOE/E

Category: Mathematics, physics, earth sciences (Since 2008)
Title : **Fostering top leaders in mathematics - broadening the core and exploring new ground**
Leader : Professor Kenji Fukaya,
Graduate School of Science
URL : gcoe.math.kyoto-u.ac.jp/english

Category : Mathematics, physics, earth sciences (Since 2008)
Title : **The Next Generation of Physics, Spun from Universality and Emergence**
Leader : Professor Hikaru Kawai,
Graduate School of Science
URL : www.scphys.kyoto-u.ac.jp/gcoe/index_e.html

Category : Mechanical, civil engineering, architectural and other fields of engineering (Since 2008)
Title : **Global Center for Education and Research on Human Security Engineering for Asia Megacities**
Leader : Professor Yusuru Matsuoka,
Graduate School of Engineering
URL : hse.gcoe.kyoto-u.ac.jp

Category : Social sciences (Since 2008)
Title : **Global Center of Excellence for Reconstruction of the Intimate and Public Spheres in 21st Century Asia**
Leader : Professor Emiko Ochiai,
Graduate School of Letters
URL : www.gcoe-intimacy.jp

Category : Interdisciplinary, combined fields (Since 2008)
Title : **Energy Science in the Age of Global Warming -Toward CO_2 Zero-emission Energy System**
Leader : Professor Takeshi Yao,
Graduate School of Energy Science
URL : www.energy.kyoto-u.ac.jp/gcoe/en

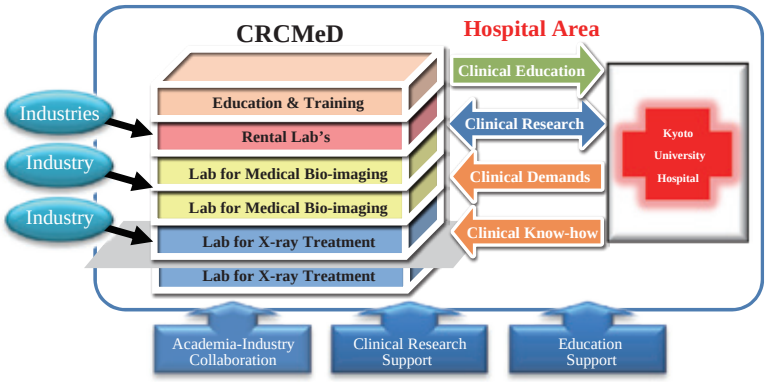
Category : Interdisciplinary, combined fields (Since 2009)
Title : **Sustainability/Survivability Science for a Resilient Society Adaptable to Extreme Weather Conditions**
Leader : Professor Kaoru Takara,
Disaster Prevention Research Institute
URL : ars.gcoe.kyoto-u.ac.jp/index.php?id=3

Clinical Research Center for Medical Equipment Development (CRCMeD)

CRCMed Director
Michiaki Mishima

The **Clinical Research Center for Medical Equipment Development (CRCMeD)** was established in 2011 in order to accelerate product development in innovative medical equipment and devices to support all stages throughout early diagnosis and treatment. Clinical research is a critical part of the medical product development process. The key function of the CRCMed is to promote academia-industry collaboration in this clinical research field.

Established on July 1, 2011
Building Area 4,635m²

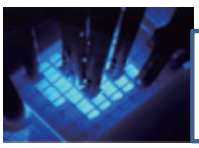


The most advanced institute for BNCT

Professor **Koji Ono**

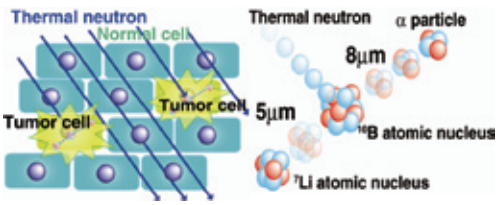
Boron Neutron Capture Therapy (BNCT) is a binary treatment for cancers. The ^{10}B nucleus absorbs thermal neutrons at much higher probabilities than other elements in the body, and instantly splits into two high linear energy transfer particles, an α-particle and a Li atomic nucleus, with a total range of 13 μm, which corresponds to general cell diameter. Therefore, with the combination of pre-injecting ^{10}B-compound to selectively accumulate in cancer lesions, and thermal neutron irradiation, we are able to selectively destroy cancers. A huge amount of neutrons are necessary for BNCT and the research reactor is used as a neutron source.

At the Kyoto University Research Reactor Institute (KURRI), more than 330 patients with no other viable treatment options, have received BNCT to the present. This is the largest number of BNCT treatments in the world. The kind of cancers that has been treated by BNCT include malignant brain tumors, malignant melanoma, recurrent H & N cancers, multiple liver cancers and lung cancers, especially malignant pleural mesothelioma. The effectiveness of BNCT has been clearly demonstrated on the first 3 cancers. KURRI was the first in the world to begin BNCT for malignant melanoma, H & N cancer and mesothelioma.



Kyoto University
Research Reactor Institute
www.rri.kyoto-u.ac.jp/en/

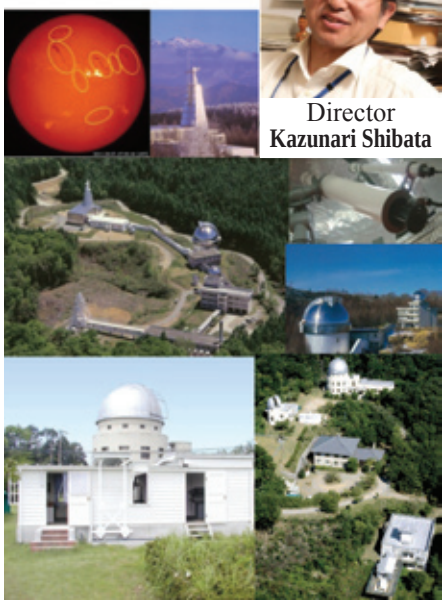
www.rri.kyoto-u.ac.jp/en/RD/LSMS/lsms04_pro.html



Kyoto University's Observatories:

The Kwasan Observatory in Kyoto City & Hida Observatory in Gifu prefecture

Director
Kazunari Shibata



The Hida observatory was built in 1968. It is located in the Japanese Northern Alps, where the clean air provides us with one of the best observational sites in Japan. We have several noteworthy instruments at Hida observatory, including the Domeless Solar Telescope (DST), and 65cm refractor telescope. We use these large, powerful telescopes to conduct pioneering research.

The Kwasan observatory, built in 1929, was historically Kyoto University's most important observation station before the construction of Hida. Today, the main activities at Kwasan are data analysis, conducting of numerical simulations using computer workstations, and academic instruction. However, high quality solar observations are still carried out on a smaller scale.

The observatory's instruments and workstations are made available for educational use at the high school level, as well as for students from other universities. We also continue to keep the observatory open to the general public.

www.kwasan.kyoto-u.ac.jp/general/index_en.html

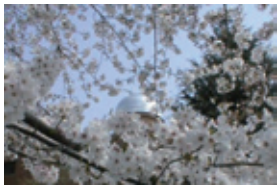
The current rise in solar activity is being monitored and reported.
www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/110916_1.htm

Research Projects

Solar Physics: High resolution observations are carried out intensively utilizing the 60cm DST and Solar Magnetic Activity Research Telescope (SMART), to investigate the processes related to the storage, release, and transport of energy in the solar atmosphere. The main areas of interest are the evolution of small-scale magnetic fields and associated dynamical phenomena, sunspots, coronal heating, flares, prominence eruptions, and related space weather research. These studies also provide us with various hints to aid in our understanding of the origin of stellar and galactic activity as well as the role of such things as magnetized plasma in the universe. Coordinated observations and data analysis are carried out with domestic and overseas institutions, such as NASA and the National Astronomical Observatory of Japan (NAOJ).

Solar and Astrophysical Plasma Physics: Using theoretical, numerical, and observational methods, we work to solve the puzzles relating to highly explosive phenomena in the universe, especially magnetohydrodynamic (MHD) explosions and jets. Observational work deals with solar flares, stellar flares, and variable stars. There are a variety of different objectives in our theoretical and numerical studies, including understanding active galactic nuclei (AGN), jets ejected from protostars, MHD processes in accretion disks, and gamma-ray bursts, all of which are often referred to as the deepest mysteries of the universe.

Stellar Physics: Our research topics include stellar atmospheric structure and chemical composition, stellar active phenomena, stellar winds, cataclysmic variable stars, black holes, accretion disks and gamma-ray bursts. We investigate these topics using spectroscopic imaging and polarization observations using telescopes in Okayama and the NAOJ Hawaii observatories. In collaboration with the Department of Astronomy, Nagoya University, NAOJ and Nano-Optonics Energy, Inc., a 3.8m optical and infrared telescope is constructed with new technologies in Okayama prefecture.



www.kusastro.kyoto-u.ac.jp/

Micro/Nano Fabrication Hub in Kyoto Univ.

Part of the Low-Carbon Research Network (LC-net)

The Low-Carbon research network that was proposed in 2010 is under development by the MEXT as a new research infrastructure network in Japan with a focus on environmentally friendly energy technologies. Its total budget is 13 billion JPY. The research accomplishments and nanotechnology discoveries will be integrated into practical environmental technologies and systems to accelerate new developments and applications.

Professor
Hidetoshi Kotera

Achieving innovative research thorough the fusion of research fields, the LC-net is composed of three HUB centers – one of which is Kyoto University – and 15 other satellite research centers. All of the centers will be equipped with advanced systems and apparatus. The three HUB centers are placed to work for the development of new materials, the fabrication of new micro and nano devices and for carrying out their testing.

The role of Kyoto University as the micro/nano fabrication hub is to accelerate the research and the development of various innovative materials and micro/nano devices, and to contribute to technology transfer in the industrial field for the realization of a low-carbon future. The research fields are divided into the four domains of “Creation”, “Store”, “Use” and “Return”. More than 70 pieces of equipment are accessible by researchers and students at the Hub and are used for fabricating and evaluating micro/nano devices of various materials. Users are able to handle 4 and 6 inch wafers at the Hub.

Specialized technical engineers provide every user with training and support for the use of various fabrication processing and testing machines to carry out thin film deposition, photo and EB lithography, photoresist processing, patterning, dry and wet etching, bonding, dicing and evaluation. Teleconferencing systems serve to provide seamless communication between the Hub and each user’s laboratories.

www.mnhub.cpier.kyoto-u.ac.jp/index.html
(Japanese Only)

The **RISING Project**

Professor
Zempachi Ogumi

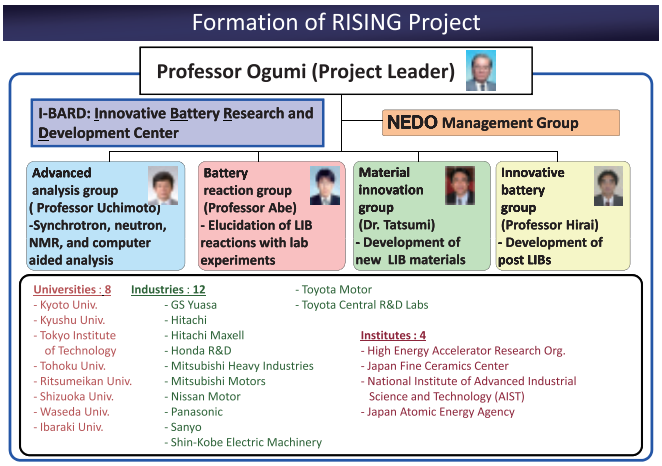
The **R&D Initiative for Scientific Innovation of New Generation Batteries (RISING)** project is an endeavor to develop innovative rechargeable batteries for a green revolution within Japan at this time of tough competition.

Cooperation between Kyoto University and NEDO (New Energy and Industrial Development Organization) has been ongoing to support this framework since 2009, and currently 12 industries and 12 academic institutions participate from across the nation.

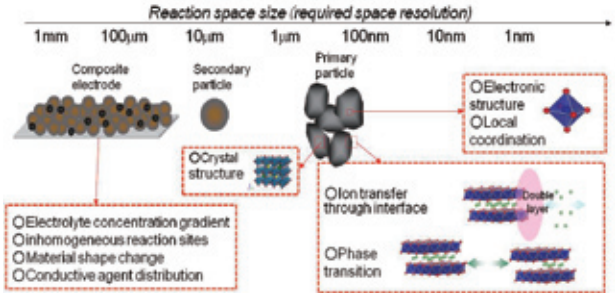
Objectives:
1. To strengthen the battery industry within Japan at this time of tough global competition.
2. To develop a new generation of batteries with high performances of greater than 500Wh/kg.
3. To act as a central hub for the battery community.

Project Duration:
Planned for 7 years:
2009 through 2016

Budget:
3 billion JPY per year



Three important targets for the RISING Project are; 1) establish advanced analytical methods based on close collaboration between industrial society and academia, to understand the phenomena in LIBs and to improve the performance 2) develop novel technology to realize innovative batteries with its performance as high as 500Wh/kg 3) form an interdisciplinary community for developing new generation batteries.



Towards this goal, what is most important is to realize that the battery reaction proceeds in a variety of space and time scales; from the sub-nanometer range where the charge transfer reaction takes place, to the centimeter range which corresponds to the size of the whole battery. This structural size hierarchy gives non-uniform distribution in the battery reaction sites so that we often fail to understand the details of the phenomena, kinetics and stability. Accordingly it is necessary to elucidate these phenomena in broad space and time ranges. We believe that to understand the limitations of LIBs with advanced analytical methods is the most effective way to lead to new concepts for innovative batteries.

www.rising.saci.kyoto-u.ac.jp/pdf/RISING_Battery_Project_en.pdf

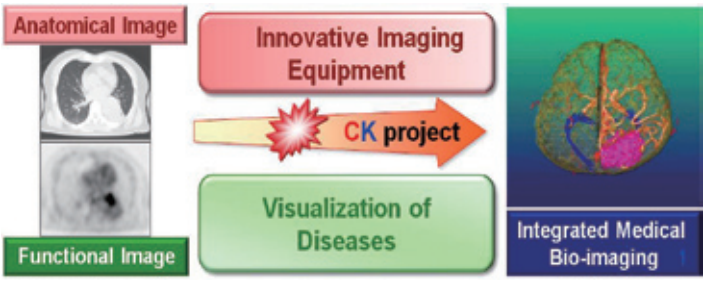
CK Joint Project with Canon

The **Innovative Techno-hub for Integrated Medical Bioimaging** project, also known as the **CK project**, combines the university's background in integrated science and technology and its excellent record in clinical research, with Canon's technical strengths in product development. Initiated in 2006, it is expected to continue on a 10-year MEXT supported budget.

The goals of innovating treatments in medicine has become the drive behind this work. Our long-term aims are to propose and realize new imaging-diagnosis techniques.

C: Canon
K: Kyoto University

Project Members:
47 Researchers and Postdocs
(School of Engineering, KU)
56 Researchers and Medical doctors
(School of Medicine, KU)
50 Researchers
(Canon)
Budget Total:
10 billion JPY over 10 years
(2006-2015)



For further information: ckpj.t.kyoto-u.ac.jp/?lang=en

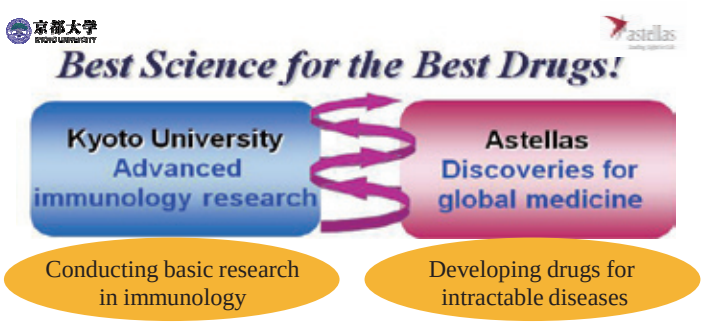
AK Joint Project with Astellas

The **Center for Innovation in Immunoregulative Technology and Therapeutics (AK Project)** collaborating with Astellas at the Fusion Laboratory within the School of Medicine.

- Innovating drug development systems.
- Identifying and validating new drug targets.
- Developing new drugs for allergies, autoimmune diseases, cancer, and immuno-suppression.
- Nurturing young talents comprehensive for drug discovery and intellectual properties.
- Funded by the MEXT for the promotion of science and technology.

Project Members:
45 Researchers and Postdocs
(KU and worldwide)
MD: 19
PhD (Non-MD): 26
52 Researchers (Astellas)
3 Intellectual property managers
14 Technical assistants

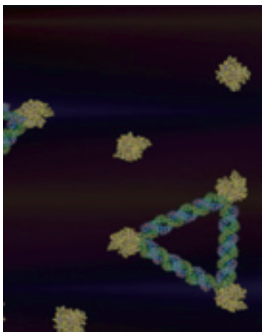
Budget Total:
11.6 billion JPY
over 10 years (2007-2016)



For further information: www.ak.med.kyoto-u.ac.jp/index.html
(Japanese only)

Hakubi Project : Fostering Young Researchers

The *Hakubi* Project welcomes applications from researchers all over the world regardless of the applicant's nationality. It is a project to support young researchers in any range of basic and applied studies in all academic fields. The following are introductions to recent research activities produced by two Hakubi researchers.



Synthetic RNA-protein nanostructure shaped like an equilateral triangle

RNA and RNA-Protein (RNP) Architectures

Associate Professor Hirohide Saito

The field of synthetic biology and bioengineering has promising outlooks for improving human health, and particularly for understanding the self-organizing principle of biological molecules and systems in life. Dr. Hirohide Saito, Associate Professor of the Hakubi Project, focuses on RNA and RNA-protein (RNP) architectures to build nanoobjects and to regulate cellular functions in a customized manner. This year, he succeeded in developing new RNP design technologies (two papers published this year; Nature Communications 2:160 and Nature Nanotechnology 6:116). Continuously, he aims to gain an understanding of the design principles of biological molecules and systems by employing "bottom-up" synthetic approaches.

Bhutanese Buddhism Research Project (BBRP)

Assistant Professor Seiji Kumagai

Interview with the principal Religious Minister Dorji Lopon (August 25, 2011)

Bhutan attracts attention throughout the world because of its promotion of the concept of Gross National Happiness (GNH). Recently, the Japanese media too has noted this as a significant guiding principle for social and political prosperity. In order to understand the concept of GNH in its proper context, we must examine the Bhutanese Buddhist doctrines in which it is rooted. Although studies of Bhutanese society and our understanding of its cultural strata have taken off in recent years, Bhutanese Buddhist doctrine has remained largely unexplored. It is to meet this need for academic focus on the religious roots of contemporary Bhutanese cultural trends that Dr. Kumagai started the BBRP in collaboration with the Center for Bhutan Studies, establishing its head office at Kyoto University. Dr. Kumagai, along with four post-doctoral researchers, runs the BBRP, which has adopted as its mission the publication of classic Bhutanese Buddhist texts, as well as the development of philological, historical, and anthropological studies in the area. This is the first ever full-scale research project on Bhutanese Buddhism.

■ What is the *Hakubi* ? How do I apply?

The term Hakubi literally means "white eyebrows" in Japanese. This project is named after a legend in Shu (蜀), one of the states of the Three Kingdoms era in ancient China. According to the legend, in the Kingdom lived five brothers with extraordinary talents. Since the fourth brother, who was particularly outstanding, had white hairs in his eyebrows, the term *Hakubi* has come to refer to the most prominent individuals. The call for applications will open for the fourth time in March, 2012.

■ **For further information:** www.hakubi.kyoto-u.ac.jp/eng