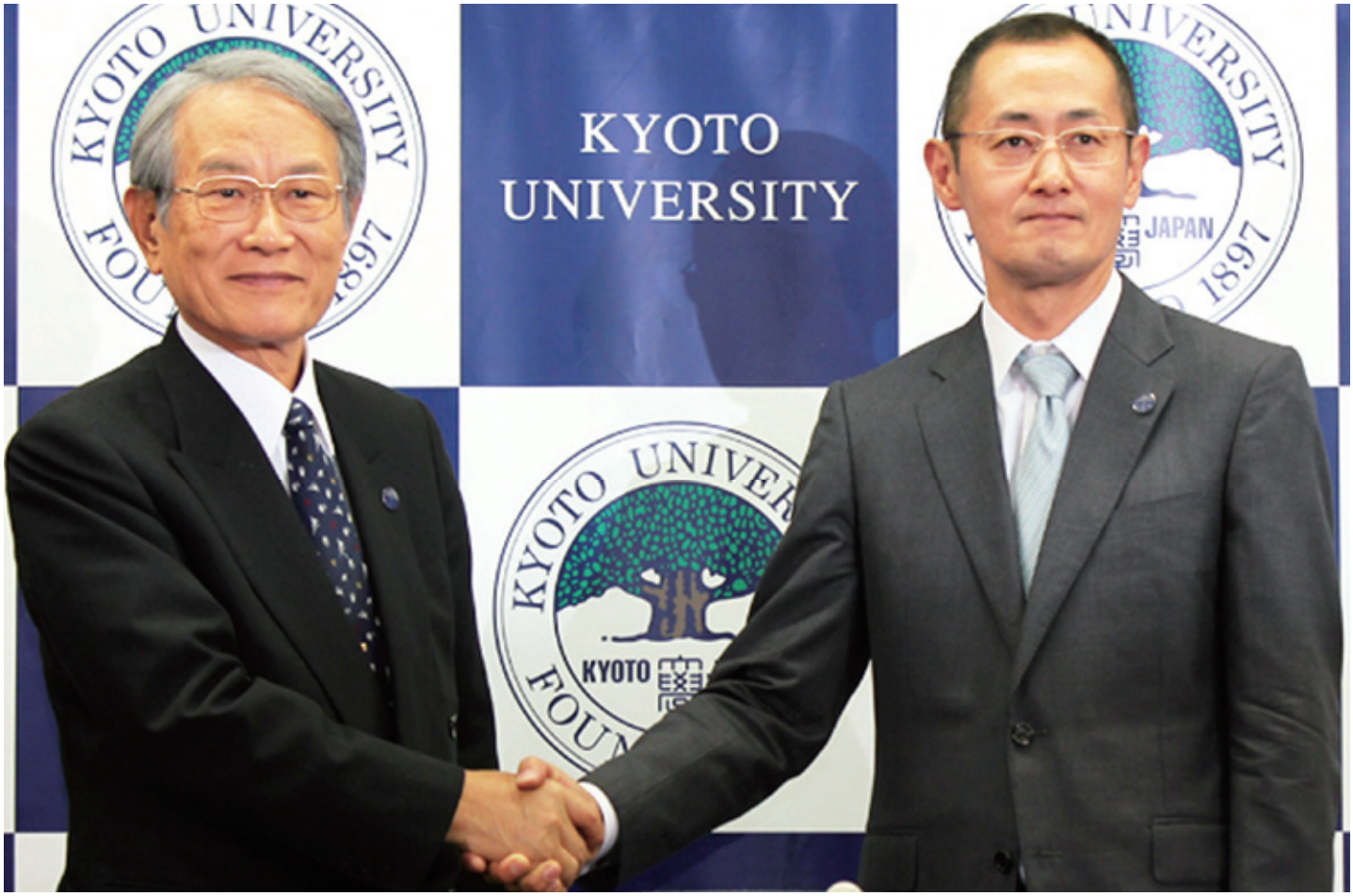
KYOTO UNIVERSITY

Research Activities 2012

Nobel Laureates at Kyoto University

Vol.2 Special Edition December



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Front cover: From left: President Matsumoto and Dr. Yamanaka
at the press conference for the Nobel Prize announcement

Message from the President

President Hiroshi Matsumoto

Welcome to this special edition of *Kyoto University Research Activities,* commemorating the award of the 2012 Nobel Prize in Physiology or Medicine to Dr. Shinya Yamanaka, director of Kyoto University's Center for iPS Cell Research and Application (CiRA).

The attainment of the award is a testament to the great efforts and passion of Dr. Yamanaka and the many researchers who have worked alongside him. As president of Kyoto University, I applaud their tremendous efforts and accomplishments, and extend my heartfelt congratulations to every member of the research team.

The research achievements for which the prize was awarded have toppled preconceived notions and opened new realms of possibility in biology and medicine. I have no doubt that they will pave the way for yet further remarkable advances, and that their influence will extend beyond the fields of biology and medicine to have a profound effect on science and technology as a whole, as well as on the humanities and social sciences.

Dr. Yamanaka is Kyoto University's eighth Nobel laureate, and in this issue we will also introduce his seven predecessors. The majority of those laureates did their most significant work at Kyoto University, and we are dedicated to maintaining that standard of achievement through continually enhancing our capability to foster world-class talent.

As the current harsh economic climate continues to exert adverse effects on the international research environment, it is my hope that achievements of Dr. Yamanaka and the other outstanding researchers featured will be a source of inspiration for students and researchers around the world.

December 2012

H. Matsumoto

Hiroshi Matsumoto
President, Kyoto University

Dr. Shinya Yamanaka was awarded the 2012 Nobel Prize in Physiology or Medicine jointly with Sir John B. Gurdon

"for the discovery that mature cells can be reprogrammed to become pluripotent"

Dr. Shinya Yamanaka and his research team reported the world's first generation of mouse iPS cells in 2006 and the generation of human iPS cells in 2007. The team also reported the establishment of mouse iPS cells using plasmid DNA vectors in 2008, one of the first methods to generate such cells without requiring gene insertion. Many researchers around the world are now working on studies with the use of iPS cells, which may one day find applications in regenerative medicine and as a research tool in drug discovery. In order for such applications to become a reality, however, it will be necessary to establish optimal protocols for the generation of iPS cells by deepening our understanding of the mechanisms that underlie the reprogramming of differentiated cells into an undifferentiated state.

Dr. Yamanaka commented that he is particularly happy to have been awarded the prize jointly with Sir John B. Gurdon, a Fellow of the Royal Society and professor at and founder of the Wellcome Trust/Cancer Research UK Gurdon Institute at the University of Cambridge. In 2009, Dr. Yamanaka and Sir Gurdon were jointly awarded the Albert Lasker Award for Basic Medical Research "for discoveries concerning nuclear reprogramming, the process that instructs specialized adult cells to form early stem cells — creating the potential to become any type of mature cell for experimental or therapeutic purposes."

Dr. Shinya Yamanaka

Director and Professor
Center for iPS Cell Research and Application (CiRA)

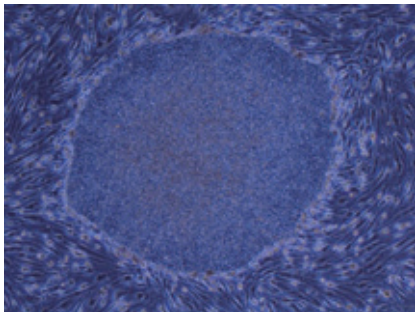
Principal Investigator,
Institute for Integrated Cell-Material Sciences (iCeMS)

Dr. Shinya Yamanaka received his M.D. from Kobe University in 1987 and his Ph.D. from Osaka City University in 1993. After working as a postdoctoral fellow at the Gladstone Institute of Cardiovascular Disease in San Francisco, he became an assistant professor at Osaka City University in 1996. He was appointed as an associate professor at Nara Institute of Science and Technology in 1999, and a professor in 2003. He moved to Kyoto University in 2004, and since 2008 has served as the director of the university's Center for iPS Cell Research and Application (CiRA). In addition to the Nobel Prize in Physiology or Medicine, he has received several other awards including the Albert Lasker Award for Basic Medical Research, the Canada Gairdner International Award, the Imperial Prize, the Japan Academy Prize, and the Kyoto Prize.

Key Research Paper by Dr. Yamanaka Now Available Online

Induction of Pluripotent Stem Cells from Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors, a groundbreaking research paper by Dr. Yamanaka, is now available for free public download via the Kyoto University Research Information Repository (KURENAI). Dr. Yamanaka was awarded the Nobel Prize for Physiology or Medicine on the basis of this key publication.

repository.kulib.kyoto-u.ac.jp/dspace/bitstream/2433/159777/1/j.cell.2006.07.024.pdf



Dr. Shinya Yamanaka's award is the eight Nobel Prize to be garnered by researchers affiliated with Kyoto University. Beginning in 1949 with theoretical physicist Hideki Yukawa, Japan's first Nobel laureate, this string of honors serves as a concrete testament to Kyoto University's status as one of the most dynamic and accomplished research universities in Asia.

Since its foundation in 1897, Kyoto University has been dedicated to cultivating a liberal and vibrant academic environment conducive to quality education, interdisciplinary dialogue, and groundbreaking research. That rich academic culture is continually refined and refreshed by the university's lineage of outstanding scholars, and continues to provide fertile ground for award-winning innovation and creativity.

The following section features introductions to the seven Nobel laureates who preceded Dr. Yamanaka, and the remainder of the booklet highlights selected endeavors by Kyoto University's current generation of pioneering researchers.

8 Nobel Laureates associated with Kyoto University

Hideki Yukawa 1949	**Sin-Itiro Tomonaga** 1965	**Kenichi Fukui** 1981	**Susumu Tonegawa** 1987	**Ryoji Noyori** 2001	**Makoto Kobayashi** 2008	**Toshihide Maskawa** 2008	**Shinya Yamanaka** 2012

Hideki Yukawa

Nobel Prize in Physics, 1949

The bronze bust of Dr. Yukawa, in front of the building of Research Institute for Fundamental Physics

Dr. Hideki Yukawa, a theoretical physicist, was a student at Kyoto Imperial University and became a professor at Kyoto University in 1939.

Dr. Yukawa proposed a theory in 1935, with regard to the coupling between protons and neutrons, which constitute an atomic nucleus. In such couplings the proton has a positive charge, whereas the neutron is changeless. Therefore, the coupling between them cannot be explained by electric forces. Dr. Yukawa's theory proposed that the proton and the neutron absorb and emit a certain particle by which the coupling between them is held. He predicted that the mass of this particle, which was later called a meson, is 200 times that of the electron.

In 1937, a new particle with the predicted meson mass was discovered. Moreover, Cecil Powell, a British physicist, experimentally discovered a meson mediating the nuclear force in 1947, which demonstrated Dr. Yukawa's theory. The Nobel Prize in Physics was awarded to Dr. Yukawa for his theory in 1949. His receipt of the award gave a great deal of encouragement to the Japanese people in the period just after the Second World War.

Sin-Itiro Tomonaga

Nobel Prize in Physics, 1965

Dr. Sin-Itiro Tomonaga was a physicist and a classmate of Hideki Yukawa, also a Nobel Laureate, at Kyoto Imperial University.

Force does not directly and instantaneously act on a remote object, but is transmitted through an intervening field. This viewpoint is important in constructing a theory consistent with the theory of relativity.

In 1943, Dr. Tomonaga formulated the theory of quantum fields in a relativistically covariant form to establish the "super-many-time theory," completing the quantum field theory.

In the 1930s to 1940s, researchers of the quantum mechanics of fields faced a serious problem: Theoretical calculation of the electron mass gave infinity, inconsistent with the measurement. In 1946, Dr. Tomonaga solved this problem by the "renormalization theory." In 1965, Dr. Tomonaga was awarded the Nobel Prize in Physics for his fundamental work in quantum electrodynamics, which greatly enhanced understanding of the physics of elementary particles.

Kenichi Fukui

Nobel Prize in Chemistry, 1981

Dr. Kenichi Fukui, a chemist, was a professor at Kyoto University from 1951 to 1982. Dr. Fukui strived to theoretically elucidate chemical reactions using quantum mechanics. Classical theory of chemical reactions based on electrical attraction between a positively charged atom and a negatively charged atom cannot explain all chemical reactions. Quantum mechanics dictates the existence of orbitals, which represent the energy and distribution of electrons in a molecule. Dr. Fukui discovered that some of these orbitals play critical roles in chemical reactions, and then provided a perfect description of the essence of chemical reactions. In 1952, he published this description, which he called the frontier electron theory (later renamed the frontier orbital theory).

The frontier orbital theory is useful in understanding and predicting numerous chemical reactions, and remains essential in today's chemistry. In 1981, Dr. Fukui was awarded the Nobel Prize in Chemistry for his achievement.

Susumu Tonegawa

Nobel Prize in Physiology or Medicine, 1987

Dr. Susumu Tonegawa, a biologist, received his bachelor's degree from Kyoto University in 1963. He is currently a professor at the Massachusetts Institute of Technology.

Lymphocytes play a major role in the immune system, which protects an organism against pathogens. Lymphocytes can express a vast variety (over one trillion) of receptors, which recognize and react with pathogens and other foreign substances. Since an organism has only 20,000 to 30,000 genes at the most, how these genes can create over one trillion lymphocyte receptors, called antibodies, was one of the greatest mysteries of life science in the 20th century.

Dr. Tonegawa discovered the mechanism for producing this enormous antibody diversity. With regard to antibodies, a child inherits only the components of the genes from his or her parents, and those components are then combined. This mechanism of producing the diversity allows organisms to fully respond to the invasion of extraneous substances and environmental changes that occur over tens of thousands of years. Dr. Tonegawa was awarded the Nobel Prize in Physiology or Medicine in 1987 for this discovery.

Ryoji Noyori

Nobel Prize in Chemistry, 2001

Dr. Ryoji Noyori, a chemist, received his Ph.D. degree from Kyoto University in 1967. He is currently a professor at Nagoya University and president of RIKEN, a large natural sciences research institute in Japan founded in 1917.

A pair of "left" and "right" molecules that mirror each other are called enantiomers (optical isomers), which have different properties. For example, one is advantageous, but the other is harmful. It is desirable to separately produce and use only the advantageous one of the left and right molecules. Unfortunately, however, artificial production without subtle ingenuity results in an equal amount of left and right molecules.

Dr. Noyori tackled this problem, and developed a catalyst bearing BINAP ligand in 1986. This enabled separate production of left and right substances. This reaction, called asymmetric synthesis, has been applied to a variety of industrial products and medicines, and produced useful substances. In 2001, he was awarded the Nobel Prize in Chemistry for his work on chorally catalyzed hydrogenation reactions.

Makoto Kobayashi

Nobel Prize in Physics, 2008

Toshihide Maskawa

Dr. Makoto Kobayashi is a physicist who worked at Kyoto University after receiving his Ph.D. degree from Nagoya University in 1972. Dr. Toshihide Maskawa, also a physicist, received his Ph.D. degree from Nagoya University in 1967. He was director of the Yukawa Institute for Theoretical Physics at Kyoto University from 1997 to 2003, and is currently director of the Maskawa Institute for Science and Culture at Kyoto Sangyo University.

At the beginning of the universe the Big Bang produced equal amounts of matter and anti-matter through pair-creations. As the universe expanded and cooled, much of this matter and anti-matter was annihilated. If perfect symmetry between matter and anti-matter (CP symmetry) exists, then all the matter and anti-matter in the universe would have been completely annihilated, and consequently matter could not have survived. However, this is not the case. The symmetry between matter and anti-matter is, in fact, imperfect and slightly broken (CP violation). This asymmetry has resulted in only matter surviving to form the universe which we observe today. This slight violation of CP symmetry was first confirmed by a particle physics experiment at Brookhaven National Laboratory in 1964.

In 1972, Dr. Kobayashi and Dr. Maskawa, proposed a new mechanism (Kobayashi-Maskawa theory) to explain CP violation in the framework of a unified gauge theory of the electroweak interaction, which had just been established at that time. They predicted that the number of quarks should be at least six in order for this mechanism to work. However, at this time only three quarks were known. The remaining three quarks that they predicted have subsequently been found experimentally (six quarks have been found in total). Furthermore, by 2002, two precision experiments using B-mesons, which were conducted in Japan and the US, confirmed that CP violation can consistently be explained by the Kobayashi-Maskawa theory.

The Kobayashi-Maskawa theory is an important part of the standard model of elementary particles, which is based on the current gauge theory. In 2008, these two physicists were jointly awarded the Nobel Prize in Physics for this work.

Kobayashi-Maskawa Memorial Room

[right]
North Comprehensive Education and Research Building, established in 2011, also called the Maskawa Memorial Hall in commemoration of Dr. Maskawa's award.

Entrance

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Dr. Maskawa's Nobel Medal

Prizes and Awards Other than Nobel Prize

2 Fields Medals | 1 Gauss Prize | 4 Lasker Awards

Heisuke Hironaka 1970 | Shigefumi Mori 1990 | Kiyosi Itō 2006 | Susumu Tonegawa 1987 | Yasutomi Nishizuka 1989 | Yoshio Masui 1998 | Shinya Yamanaka 2009

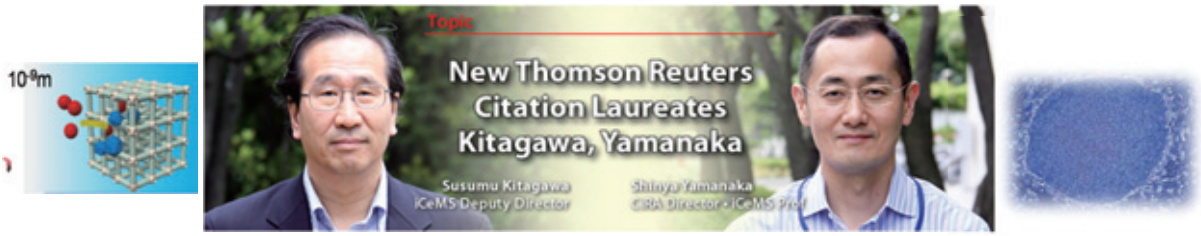
2 Japan Prizes | 3 Kyoto Prizes

*Photos provided by the Japan Prize Foundation

*Photos provided by the Inamori Foundation

Makoto Nagao 2005 | Masatoshi Takeichi 2005 | Chushiro Hayashi 1995 | Kiyoshi Ito 1998 | Shinya Yamanaka 2010

2010 Thomson Reuters Citation Laureates



Thomson Reuters announced on the 21st that Kyoto University's Institute for Integrated Cell-Material Sciences (iCeMS) Deputy Director Susumu Kitagawa as well as the university's Center for iPS Cell Research and Application (CiRA) Director and iCeMS Dr. Shinya Yamanaka are among the 21 recipients of its 2010 Thomson Reuters Citation Laureates.

Laureates typically rank among the top one-tenth of one percent (0.1%) of researchers in their fields, based on citations of their published papers over the last two decades.

Dr. Susumu Kitagawa
Prize Category: **Chemistry**
Reason:
For the design and development of porous metal-organic frameworks, whose applications include hydrogen and methane storage, gas purification, and gas separation, among others.

Dr. Shinya Yamanaka
Prize Category: **Physiology or Medicine**
Reason:
For the development of induced pluripotent stem cells.

Released September 21st 2010, on iCeMS website.

Center for iPS Cell Research and Application (CiRA)


Director Shinya Yamanaka at his office

The Center for iPS Cell Research and Application (CiRA) was established in April 2010 as the world's first institution focusing on induced pluripotent stem cells (iPS cells). Dr. Shinya Yamanaka, who pioneered the research field of iPS cell technology, directs the institute.

Equipped with a cell processing facility and laboratory animal research facilities, CiRA is comprised of four research departments: Reprogramming Science, Cell Growth and Differentiation, Clinical Application and Regulatory Science. Twenty-eight principal investigators work here to develop medical and pharmaceutical applications for iPS cells.

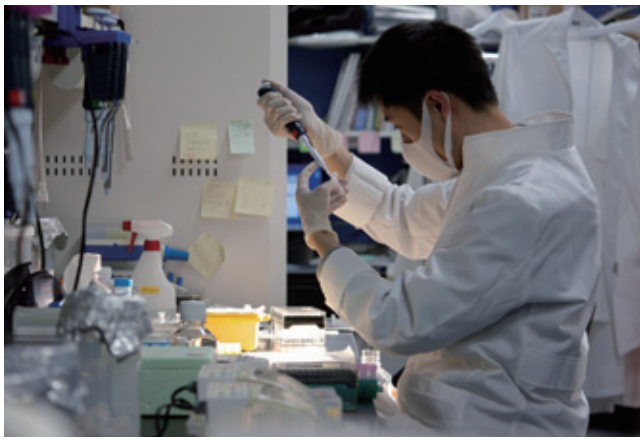
www.cira.kyoto-u.ac.jp/e/

CiRA's Goals in the first 10 years:

1. Establishment of basic technology and protect intellectual property rights
2. Creation of iPS cells for use in regenerative medicine
3. Conduct of preclinical and clinical studies
4. Development of therapeutic drugs using patient-derived iPS cells intellectual property


CiRA Research Building

CiRA has now celebrated the second anniversary of its establishment. Supported by assistance from the Japanese government and encouragement from many individuals, their research activities are making steady progress, and the number of scientific and administrative staff has now grown to about 200 members from 120 when the center was established.



Lecturer Kazutoshi Takahashi was awarded the NYSCF Robertson Prize

Kazutoshi Takahashi,
Lecturer,
Principal Investigator,
CiRA

The New York Stem Cell Foundation (NYSCF), a non-profit organization conducting cutting-edge translational stem cell research in its laboratory in New York City and supporting research by stem cell scientists at other leading institutions around the world, awarded Lecturer Kazutoshi Takahashi, PhD, CiRA with the NYSCF – Robertson Prize for his extraordinary achievements in translational stem cell research. The announcement came just a day after Dr. Yamanaka and Sir John Gurdon were awarded the Nobel Prize in Physiology or Medicine.

Lecturer Takahashi, a postdoctoral researcher in Dr. Yamanaka's laboratory, has played an important role in the research on reprogramming of differentiated cells into iPS cells, especially in finding four initialization factor for establishing mouse iPS cells. He was the lead author of the paper published in 2006,"*Induction of Pluripotent Stem Cells from Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors*", which is a key research paper detailing the work of Dr. Yamanaka.

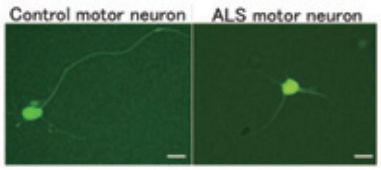
www.cira.kyoto-u.ac.jp/e/research/ktakahashi_summary/

Anacardic acid found to rescue certain ALS abnormalities in experimental drug screening assay using motor neurons from ALS patient-specific iPSCs

Associate Professor Haruhisa Inoue – CiRA [left]
Researcher Naohiro Egawa – CiRA [right]

A research group at CiRA has successfully recapitulated amyotrophic lateral sclerosis (ALS) – associated abnormalities in motor neurons differentiated from induced pluripotent stem cells (iPSCs) obtained from patients with familial ALS, a late-onset, fatal disorder, also known as for Lou Gehrig's disease. In a drug screening assay using the disease model, the team further found that the chemical compound anacardic acid can rescue some ALS phenotypes *in vitro*.

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2012/120802_1.htm
http://dx.doi.org/10.1126/scitranslmed.3004052



A control motor neuron (left) and a motor neuron derived from ALS patient-specific iPSCs (right) (COURTESY OF DR. HARUHISA INOUE'S LABORATORY)

CiRA's Logo: The DesignConcept

The logo uses the letters C, i, R and an A to form a human figure representing the CiRA philosophy: "To realize research for people and the ideal of regenerative medicine." The four colors – blue, green, red and black – applied in the logo also symbolize the four defined factors used when first inducing iPS cells, as well as interaction among patients, researchers, clinicians and iPS cells.

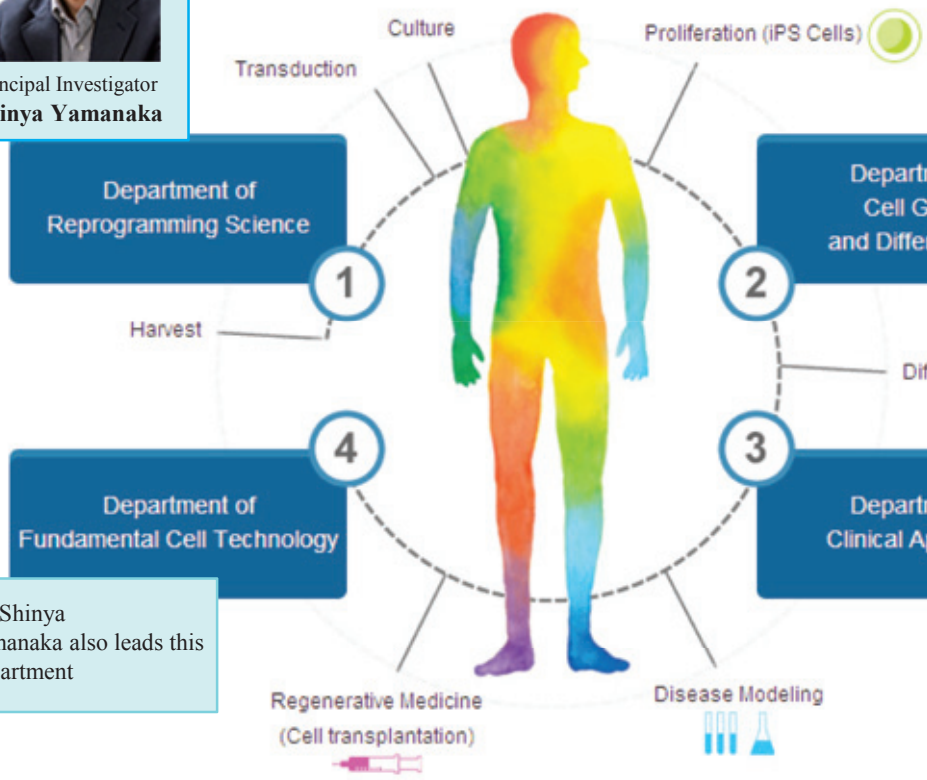
Idea: Lecturer Masato NAKAGAWA
Design: Graphic Designer Akio OKUMURA

Four Research Departments of CiRA

Principal Investigator
Shinya Yamanaka

CiRA has four research departments. They are conducting both individual and cooperative research, working towards making the promise of iPS Cells a reality for many patients who see them as a source of hope.

Principal Investigator
Junya Toguchida



Dr. Shinya Yamanaka also leads this Department

Principal Investigator
Tatsutoshi Nakahata

Research Support Division

Administration Division

Human iPS Cells Now Available through RIKEN BRC

Kyoto University has made the following iPS cells and relevant materials available to the scientific research community through the RIKEN BioResource Center (RIKEN), a public repository, for the benefit of scientific progress. The materials will be provided to non-profit academic research institutions solely for teaching and academic research purposes.

www.cira.kyoto-u.ac.jp/e/research/material_1.html

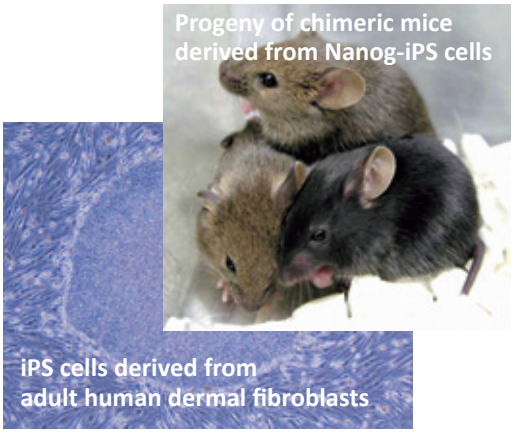
IP and Material Distribution for Commercial Uses

Requires a material transfer agreement (MTA) and patent license agreement with iPS Academia Japan, Inc., the company granted the rights to license the induced pluripotent stem cell (iPSC)-related patents from Kyoto University.

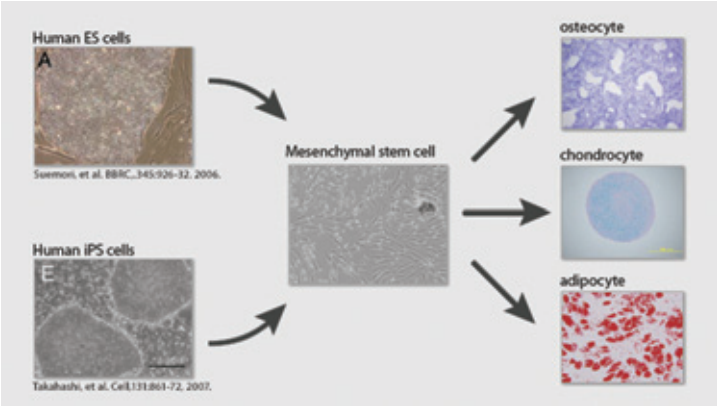
ips-cell.net/e/about/index.html

Department of Reprogramming Science

iPSCs can be generated from ordinary somatic cells, such as skin cells, through the introduction of genes, proteins, or chemical compounds. They are able both to give rise to cells of any type in the body, and to proliferate indefinitely in culture. The event that causes differentiated cells to revert to an undifferentiated state of pluripotency is known as reprogramming. Led by Dr. Shinya Yamanaka, members of the Departments of Reprogramming Science are studying the mechanisms that underlie that process with the goal of developing even safer techniques for generating effective iPSCs.



Department of Cell Growth and Differentiation



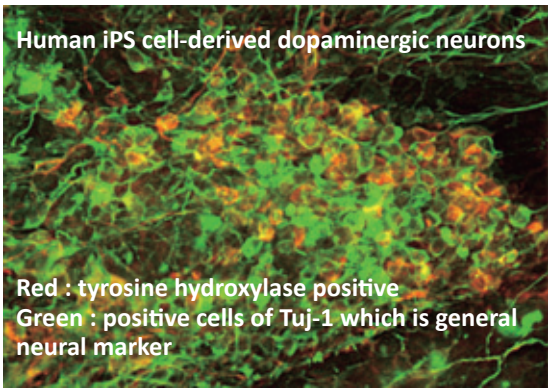
Led by Prof. Junya Toguchida, members of the Department of Cell Growth and Differentiation seek to develop methods for inducing pluripotent cells such as iPSCs and embryonic stem cells toward specific cell fates, such as mesenchymal tissue (bone, etc.) cells, cardiovascular lineages, neurons, and liver and pancreatic cells.

Using model organisms, they are also conducting preclinical studies on the safety and efficacy of somatic cells differentiated from iPSCs when transplanted into various tissues in the hopes of contributing to the development of effective iPS cell therapies.

Department of Clinical Application

Members of the Department of Clinical Application generate iPSCs from somatic cells generously donated to the Center by patients afflicted with various genetic conditions, and use them to induce differentiation into various cell types as a platform for the study of disease etiology and mechanisms of pathology.

They further use patient-derived iPSCs in the search for and testing of candidate drug compounds and therapies. This division is led by Prof. Tatsutoshi Nakahata.



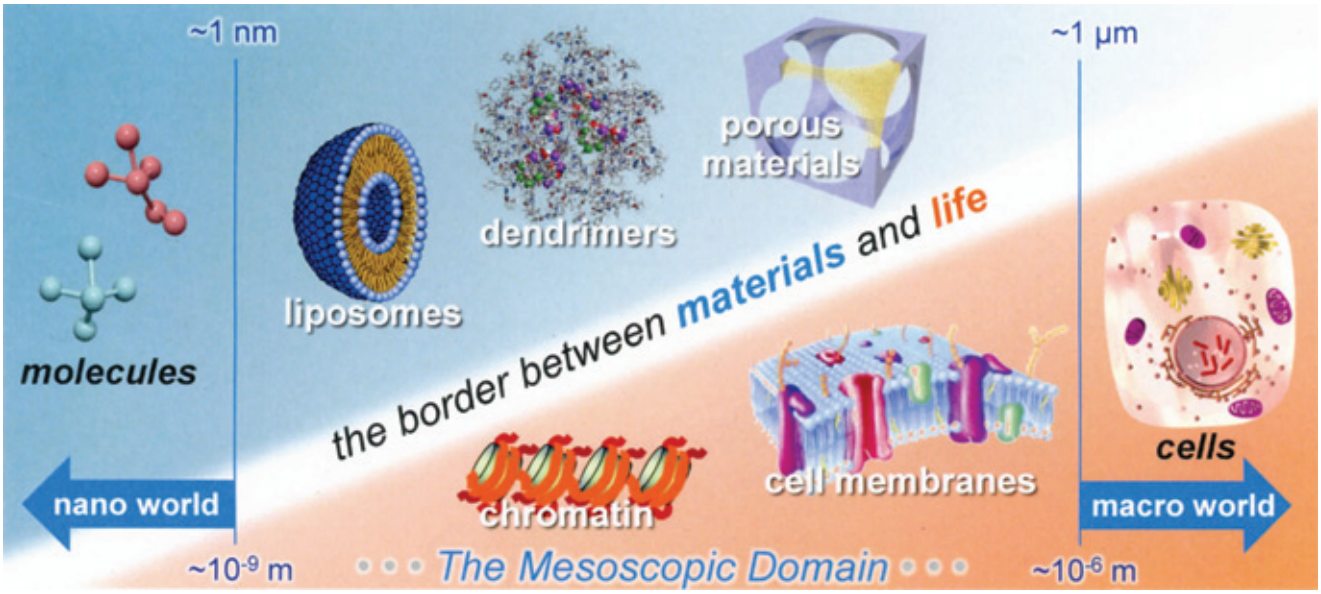
Department of Fundamental Cell Technology

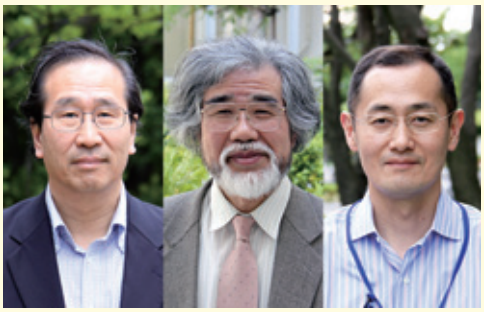
Lead by Dr. Yamanaka, the members of the Department of Fundamental Cell Technology investigate issues in the regulation and overseeing of research for the development of future therapies using iPSCs. In addition to overseeing the operations of the Facility for iPS Cell Therapy (FiT), which maintains and provides clinical-grade iPSCs, they also work to develop culture methods for the generation of cells of assured quality. They also provide technical and facilities support to other CiRA labs. The division strives to both establish reliable methods for iPS cell generation and maintenance within the institute, and to provide guidance for researchers around the world working with iPS cells.

The Vision: mastering the chemical basis of cells, and synthesizing chemical materials to mimic cellular processes

All cellular processes can ultimately be comprehended as chemical events, and such a chemical understanding of cells should allow us to mimic cellular processes using chemical materials. Our institute seeks to illuminate precisely such a *chemical basis of cells*, creating compounds to control processes in cells such as **stem cells** (*materials for cell control*) in addition to sparking cellular processes to create chemical materials (*cell-inspired materials*). Combining Kyoto University's established strength in cell biology, chemistry, and physics to delve deeply into **the mesoscale world** lying at the boundary of materials and life, we are making a concerted effort, through interdisciplinary research, to ultimately **create a new research field of integrated cell-material science.**

The Mesoscopic Domain: on the life/materials border





From left: iCeMS Director-Designate **Susumu Kitagawa**, well known for his original work on the design and development of porous coordination polymers/metal organic frameworks; iCeMS Director **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; CiRA Director and iCeMS PI **Shinya Yamanaka**, 2012 Nobel Laureate in Physiology or Medicine.

(as of December 2012)

[News archive] Sir John Gurdon speaks at iCeMS

(Posted on the iCeMS website on November 29, 2010)

On November 26, 2010, **Sir John B. Gurdon**, FRS, professor at and founder of the Wellcome Trust/Cancer Research UK Gurdon Institute at the University of Cambridge, visited Kyoto University's Institute for Integrated Cell-Material Sciences (WPI-iCeMS) to deliver a seminar on reprogramming of cell nuclei in eggs and oocytes.

Co-hosted with Kyoto University's Institute for Virus Research and Center for iPS Research and Application (CiRA), the seminar attracted over 100 iCeMS and other university department participants. During the course of the presentation, iCeMS Director Prof. **Norio Nakatsuji**, CiRA Director and iCeMS Dr. **Shinya Yamanaka**, and numerous young researchers engaged Prof. Gurdon in active discussions.

iCeMS Prof. **Akihiro Kusumi**, chief sponsor of the seminar, and Adj. Assoc. Prof. **Kazuto Kato**, who previously conducted post-doctoral research in the Gurdon lab at Cambridge, also made contributions to the debate.

Prof. Gurdon is likely best known for his work in the late 1950s and early 1960s showing that the nuclei of differentiated somatic cells retain the potential to develop into all cell types, a finding derived from experiments with South African clawed frogs (Xenopus laevis). In 2009 he received the Albert Lasker Basic Medical Award together with Dr. Yamanaka, for "discoveries concerning nuclear reprogramming, the process that instructs specialized adult cells to form early stem cells—creating the potential to become any type of mature cell for experimental or therapeutic purposes."

Sir John Gurdon (left) speaking at the 61st iCeMS Seminar with Dr. Shinya Yamanaka (right) in the audience

About iCeMS and CiRA

Dr. Shinya Yamanaka, a principal investigator at the **Institute for Integrated Cell-Material Sciences (WPI-iCeMS)**, reported in November 2007 that his team had successfully generated induced pluripotent stem cells (iPS cells) from human skin cells. In January 2008, iCeMS Director Norio Nakatsuji appointed Dr. Yamanaka as founding director of the **Center for iPS Cell Research and Application (CiRA)**, which was established under the auspices of iCeMS in order to advance iPS cell research. In April 2010, Kyoto University re-established CiRA as a full-fledged university research institute, with Dr. Yamanaka as its founding director. Since that time, both institutes have continued to collaborate closely as sister institutes, with iCeMS aiming to integrate the cell and material sciences, contributing to the advancement of stem cell research such as with ES and iPS cells, and CiRA continuing its pioneering work in the areas of regenerative medicine and drug development using iPS cells.

Fukui Institute for Fundamental Chemistry (FIFC)

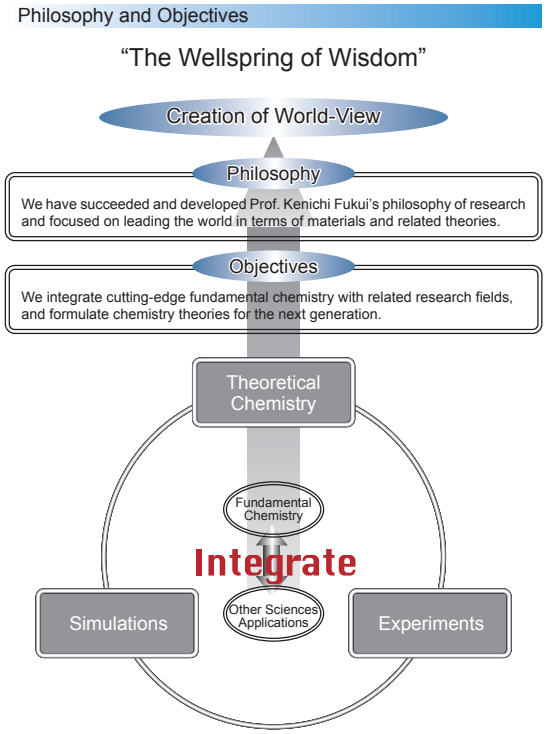
The Fukui Institute For Fundamental Chemistry (FIFC) at Kyoto University was established on April 1, 2002. The FIFC is the successor to the Institute For Fundamental Chemistry (IFC), which was founded in 1984 in commemoration of the late Prof. Kenichi Fukui's Nobel Prize award in 1981, with the aim of promoting creative research in fundamental chemistry. The IFC was donated to Kyoto University in 2002, when it was renamed as the Fukui Institute for Fundamental Chemistry. The main objectives of the Fukui Institute for Fundamental Chemistry are to promote the philosophy of Prof. Fukui in science fields and to pursue fundamental concepts in theoretical and experimental chemistry.

The FIFC is comprised of two divisions, one lab, and three groups: The General Research Division, Theoretical Research Division, International Cooperation Laboratory, Morokuma Group, Sakaki Group, and Nagase Group. Through those divisions, the institute advances computer-aided research of materials science and theoretical chemistry.

The FIFC also offers a post-doctoral research program to encourage innovation by younger scientists in all fields of fundamental chemistry.


Professor Kenichi Fukui

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



FIFC Philosophy

The FIFC has succeeded and developed Prof. Kenichi Fukui's philosophy of research, and aims to contribute to the progress of science throughout the world. Its goal is to lead world in terms of materials and related theories. They seek to be "the wellspring of wisdom."

Objectives of FIFC

- Integrate the cutting-edge fundamental chemistry with related research fields.
- Formulate chemical theory for the next-generation.
- Perform highly original research.
- Support young scientists engaged in challenging research.

Research

FIFC research ranges from theoretical chemistry to theoretical physics

- Theoretical/Computational Chemistry for Complex Systems
- Molecular Simulation of Liquids
- Theoretical/Computational Chemistry for Chemical Reactions
- Theoretical Solid State Chemistry
- Reaction Mechanisms of Metal Enzymes
- Electron Dynamics of Nano-materials
- Theoretical Simulation of Complex Molecules
- Research on Molecular Processes of Electronic Continuum States

Japan relies on imported rare earth and other rare metal elements which are utilized for advanced industries such as electronics, automotive, information technologies, architecture etc. The price of such materials is increasing and they are in short supply due to a rapid increase in demand and the influence of global economic growth and industrial expansion on the resource management policies of their countries of origin.

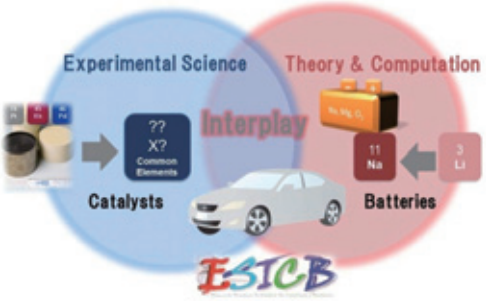
The Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched the ten-year Elements Strategy Initiative as a national research program to investigate the substation of rare-metals with alternative abundant elements in order to solve such resource issues and strengthen Japanese industry. This project aims to develop rare-metal free materials in four research fields – magnetic materials, catalysts and batteries, electronic materials, and structural materials – which are directly related to Japanese industrial competitiveness.

In 2012, the Japanese government designated two research centers at Kyoto University as leading research centers for the initiative, one for catalysts and batteries, and the other for structural materials. Both centers operate based on Prof. Kenichi Fukui's philosophy of scientific research and pursue fundamental concepts in theoretical and experimental chemistry.

Elements Strategy Initiative for Catalyst and Batteries (ESICB)

Project Leader
Professor Tsunehiro Tanaka, Graduate School of Engineering
Theoretical Research Division Supervisor, FIFC

This project aims to establish and advance elements science, develop rare-metal free catalysts and rechargeable batteries, and train young gifted scientists and engineers with the ultimate purpose of achieving sustainable development. The project is particularly concerned with elucidating the nanoscopic processes and phenomena of complex systems such as catalysts and batteries, and advancing the science describing complex systems through the interplay between theoretical and experimental sciences. It thereby seeks to develop rare-metal free catalysts and batteries by predicting new materials, and to foster young talented researchers.



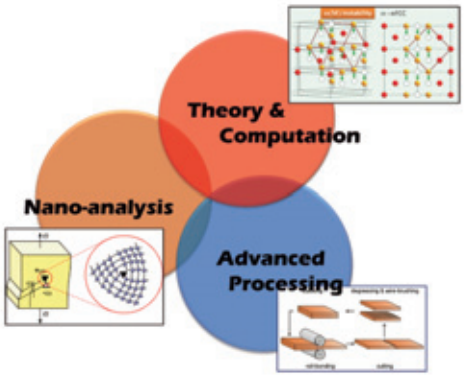
www.esicb.kyoto-u.ac.jp/

Elements Strategy Initiative for Structural Materials (ESISM)

Project Leader
Professor Isao Tanaka, Graduate School of Engineering
Ex-Director and Theoretical Research Division Supervisor, FIFC

The mission of this project is to advance the study and construction of new academic concepts for structural materials, develop industrial applications of research results, and foster young talented researchers to contribute to sustainable development.

Although they are generally a trade-off, the dual qualities of "strength" and "ductility" are essential for structural materials. They have achieved a breakthrough towards the ultimate material with both strength and ductility through multi-scale control of microstructures avoiding the use of rare metals. By combining leading-edge tools of theory and computation, and nano-analysis and advanced processing, they explore the frontier of structural materials science.



esism.kyoto-u.ac.jp/en/

■ History

The history of the Yukawa Institute for Theoretical Physics (formerly the Research Institute for Fundamental Physics) goes back to 1949, when Dr. Hideki Yukawa of Kyoto University received the first Nobel Prize awarded to a Japanese citizen. To commemorate this historic event, the president of Kyoto University proposed the establishment of a memorial hall on campus for Dr. Yukawa. In 1950, the Science Council of Japan issued a request to the central government for the allocation of special funding for the promotion of research into theoretical physics. Enthusiastic discussions among physicists all over the country ensued in support of the idea of establishing a new institution.

The Yukawa Hall was inaugurated in 1952 and in the following year (1953) it was renamed the Research Institute for Fundamental Physics (RIFP). Dr. Yukawa was appointed as the first director, and led the institute until his retirement in 1970.

The RIFP was a new type of national research center for theoretical physics, its facilities available for collaborative use by the entire community of theoretical physicists in Japan. Many physicists participated in the organization of topical workshops and international conferences at RIFP, and stayed at the institute for certain periods to work in collaboration with their peers. Those traditions are still maintained by the Yukawa Institute.

A major expansion took place in 1990 when the entire academic staff of the Research Institute for Theoretical Physics (RITP) of Hiroshima University moved to the RIFP. At the time of the unification, RITP had ten academic staff members and its research area had expanded to include cosmology, general relativity, field theory, and particle theory. As a result of the unification, the institute was reinstituted as a Joint Research Laboratory attached to Kyoto University. Although the Japanese name of the institute, *Kisobutsurigaku Kenkyujo*, remained unchanged, its English name was changed to the Yukawa Institute for Theoretical Physics (YITP) in memory of Dr. Hideki Yukawa.

In 2008, Toshihide Maskawa, the seventh director of the institute was awarded the Nobel Prize in Physics.

Yukawa Hall and the statue of Dr. Yukawa

Hideki Yukawa, seated at the center, and his colleagues. To his right are S. Tomonaga and S. Sakata. A picture taken in 1954 in front of the entrance of the Yukawa Hall.

Nobel Prize Diploma for Dr. Maskawa

■Research Groups

High Energy Physics Group

The goal of high energy physics is to elucidate the basic constituents of matters and the laws that govern their dynamics. This group aims at the understanding of fundamental laws of nature that lies beyond the Standard Model. Current research fields include: superstring theory, quantum gravity, quantum field theory and particle phenomenology.

Condensed Matter Physics Group

All matters are aggregates of numerous particles interacting with each other in various manners. This group aims at elucidating complex movements or states which do not appear until particle systems form a group or their dynamic temporal changes. Furthermore, it aims to elucidate the mode of material movement and dynamic changes in phase structure in non-equilibrium open systems including biological systems. Current research fields include: solid state physics and advanced statistical dynamics.

Nuclear Theory Group

The study of nuclear structure and nuclear interactions constitutes one of the traditional research areas of the institute. Yukawa's meson theory played a historical role in research programs at the Institute. Current research fields include: nuclear many-body physics and quark-hadron many-body.

Astrophysics Group

This group studies cosmological and astrophysical structures under extreme conditions, based on general relativity, quantum field theory and/or string theory as well as on experimental and observational data, making full use of computer simulations when necessary. Current research fields include: the early universe, high energy astrophysics, numerical relativity and gravitational waves, and higher dimensional spacetime and gravity.

■International Exchange

The YITP is one of the most important hubs of international collaboration in the field of theoretical physics in Japan. Since 1978, the YITP has held regular annual international conferences. Among those events, the Yukawa International Seminar (YKIS) has the longest history, and each year is attended by approximately 100 participants from Japan and 40 from overseas.

The YITP has hosted a number of visiting professors and short-term visitors from abroad. They collaborate with Japanese researchers and play an important role in enhancing theoretical physics research in Japan. During their time at the YITP, the visiting professors give special lectures and assist with the education of graduate students at Kyoto University.

■Program for Quark-Hadron Physics

In 2007, a program for a long-term international workshop on quark-hadron physics was adopted as a special education and research project by the government of Japan. Since its adoption, two or three long-term (one to three months) workshops have been held annually on a variety of themes related to quark-hadron physics.

Yukawa International Seminar 2011 (YKIS2011)

For further information : www.yukawa.kyoto-u.ac.jp/english/index.html

Development of Small-Molecule Tools for Cell Therapy

Cell Biology empowered by small molecules

Professor Motonari Uesugi – Institute for Chemical Research *and* iCeMS

Taking advantage of technology available in fields ranging from organic chemistry to clinical medicine, Prof. Motonari Uesugi and his research team seek to discover and use synthetic small molecules that modulate fundamental processes in human cells, specifically small-molecule adhesion factors and small-molecule growth factors. Their goals extend beyond the discovery of clinically useful molecules, to include design innovations and chemical synthesis that will lead to new, broad, and cost-effective general applications of synthetic organic molecules.

Prof. Uesugi's discoveries have made possible the investigation of complex cellular events and the improvement of cell therapies. The team has already discovered a synthetic small molecule, "adhesamine," which boosts adhesion and growth of cultured human cells. Using this molecule as a seed, Prof. Uesugi and colleagues designed a synthetic molecule that behaves just like fibronectin, a naturally-occurring protein commonly used in a range of fields from basic biology to cosmetics. The team has additionally shown that it is possible to replace fibronectin, a large protein, with a synthetic compound appropriate in size for mass chemical production. The development of this "small molecule fibronectin" is a groundbreaking contribution to chemistry, biology, and medicine.

www.icems.kyoto-u.ac.jp/e/pr/2011/05/12-tp.html

Receptor Behaviors Observed in Living Cell Membranes

Expanding drug development horizons

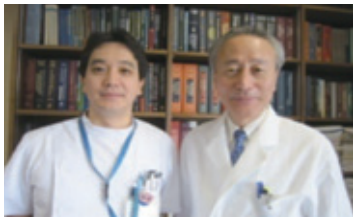
Professor Akihiro Kusumi [left] – iCeMS
Rinshi Kasai PhD [right]

Unprecedented single molecule imaging movies of living cell membranes, taken by a research team based at Kyoto University and the University of New Mexico, have clarified a decades-old enigma surrounding receptor molecule behaviors. The work focuses on G protein-coupled receptors (GPCRs), a class of molecules in cell membranes that comprise the largest superfamily in the human genome. According to iCeMS Prof. Akihiro Kusumi, "We obtained a parameter called the dissociation constant, which will allow us to predict numbers of monomers and dimers if the total number of GPCRs in a cell is known. The ability of scientists to obtain such key numbers will be essential for understanding GPCR signaling, as well as defects leading to diseases from the neuronal to the immune systems. The blocking of signal amplifications by monomer-dimer interconversions and its implications for drug design are profoundly important."

www.icems.kyoto-u.ac.jp/e/pr/2011/02/08-nr.html

Epigenetic Regulation of the TGF-beta Pathway in Ovarian Cancer

The cancer advances when genes are silenced



Professor Ikuo Konishi – Graduate School of Medicine
Assistant Professor Noriomi Matsumura – Graduate School of Medicine

Researchers at Kyoto University and Duke Cancer Institute have found evidence of epigenetics at work on a genome-wide scale in cases of ovarian cancer. The researchers performed a series of studies on cancer cell lines and primary tumor specimens from ovarian cancer patients by comparing the genome-wide gene expression profiles of cells that were treated or mock-treated with drugs that inhibit DNA methylation. From these studies they identified 378 candidate methylated genes. From this group, all 43 of the predicted genes the researchers analyzed showed methylation in ovarian cancers. The researchers found that many of these genes were part of one pathway, the TGF-beta signaling pathway. When the researchers treated tumor cells with methylation inhibitors, the TGF-beta pathway showed increased activity. In addition, the genes they studied included a cluster of genes that strongly correlated with TGF-beta pathway activity in specimens from older women, which suggested that age-related epigenetic changes can accumulate and may contribute to cancer. Two different groups of patients the team identified might need different approaches. Some women with ovarian cancer have a lower expression of these tumor-suppressing genes and may be amenable to epigenetic therapies that lead to gene reactivation. Another group of women with ovarian cancer have a higher expression of these genes, suggesting it may be possible to specifically inhibit particular components in this pathway to stop tumor development or progression.

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/101214_1.htm
www.med.kyoto-u.ac.jp/E/grad_school/introduction/1404/

Imaging Cell-Cell Communications in Living Animals

To flow, or not to flow,
——that is the question for the first red blood cells

Professor Atsuko Sehara [left] – Institute for Frontier Medical Sciences
and Graduate School of Medicine
Assistant Professor Atsuo Iida [right] – Institute for Frontier Medical Sciences

Cells produce different kinds of cell-to-cell signaling and cell adhesion molecules. Such molecules are often generated as transmembrane proteins, and their extracellular domains are cleaved off when cells send messages or detach. This process, called “ectodomain shedding”, has come into focus since the discovery of proteases that possess this ability . Questions are in what physiological contexts do these proteases play roles and how do they manage to control shedding spatiotemporally. In order to address these questions, Prof. Atsuko Sehara and her colleagues utilize transparent zebrafish embryos, in which dynamic cell behaviors can be visualized as 3D movies. Assistant Prof. Atsuo Iida succeeded in capturing the onset of blood circulation by monitoring fluorescently labeled erythrocytes and blood vessels. Unexpectedly, the earliest circulation of blood began synchronously. This synchrony was achieved by the retention of erythrocytes in the lumen of blood vessels, and then, by their simultaneous release into the plasma flow. Erythrocytes remained attached when they were devoid of a metalloprotease named ADAM8. ADAM8 shed ectodomains of cell adhesion molecules, which caused synchronous detachment of erythrocytes from blood vessels. Thus, this study demonstrated that the first erythrocytes require both heartbeat passive and proteolysis-dependent active processes to enter the circulation.

www.frontier.kyoto-u.ac.jp/rc03/index-j.html

Production of High Quality Human Embryonic Stem Cell Lines at Kyoto University

Genetic changes mapped in a diverse sample of ES Cells by international collaboration as a major step toward medical applications

Associate Professor Hirofumi Suemori – Institute for Frontier Medical Sciences
Professor Norio Nakatsuji – Director, Institute for Integrated Cell-Material Sciences

Human embryonic stem (hES) cell lines can proliferate indefinitely and differentiate into all kinds of tissues in the body. Therefore, they are considered to have great potential in medical research and applications such as cell transplantation therapy and drug discovery. Since they began deriving hES cell lines in 2003 at the Institute for Frontier Medical Sciences, they have established five hES cell lines, named KhES-1, KhES-2, KhES-3, KhES-4 and KhES-5. They have been studied extensively and characterized in detail, and so far distributed for use in over 50 research projects. They have now started a project to produce higher quality hES cell lines which can be used in clinical applications.

However, genetic changes can occur during prolonged proliferation in culture, and they cause potential risks in clinical applications. Thus, an international collaboration by the International Stem Cell Initiative (ISCI) including our group at Kyoto University began in 2008 to identify genetic changes that occur during the culture of many ethnically diverse hES cell lines. The effort, led by Prof. Peter Andrews of the University of Sheffield, analyzed 125 human ES cell lines including our five hES cell lines and 11 human induced pluripotent stem (iPS) cell lines collected from 38 laboratories across 19 countries. The study published online in *Nature Biotechnology* on Nov 27, 2011 (vol. 29, 1132-1144) revealed that most cell lines remained karyotypically normal, but change in karyotype during prolonged culture, especially in chromosomes 1, 12, 17 and 20. Copy number analysis using SNP arrays also showed that amplification of a small genomic region on chromosome 20 was found in over 20% of cell lines. These findings can be used for the accurate and cost-effective quality control of cell lines, which are needed in the application of stem cell technologies to regenerative medicine.

www.icems.kyoto-u.ac.jp/e/pr/2011/11/28-nr1.html
www.frontier.kyoto-u.ac.jp/es01/topE.htm

Mouse Genome Protection

Understanding the role of the miwi protein

Professor Shinichiro Chuma – Institute for Frontier Medical Sciences

The germline is the cell lineage that transmits genetic information to the next generation. Genetic and epigenetic changes in the germline affect embryonic development and subsequent offspring, so the genomic stability of germ cells is a critical requirement for maintaining both the individual and the species. Damage to Genomic DNA generally occurs as a consequence of physical or chemical attacks, such as from exposure to ionizing radiation, genotoxic reagents and oxidative stress. Another threat to the genome is the encoding mechanism of the genome itself, namely in the form of mobile transposable elements, which move or duplicate themselves and transpose into new genome positions. They recently discovered, in an international collaboration led by Dr. Ramesh S. Pillai at EMBL, France, the role that a particular protein plays in protecting the genome: specifically, the means by which the Miwi protein silences transposon RNAs in male mice. Among other findings, They demonstrated conclusively that disrupting the mice's capacity to produce the functional Miwi protein with RNA slicer activity leads to an inability to create viable sperm. They provide evidence for Miwi slicer activity directly cleaving transposon messenger RNAs, offering an explanation for the continued maintenance of repeat-derived Piwi proteins interacting with small RNAs (piRNAs) long after transposon silencing is established in germline stem cells. This work builds on earlier studies of our own and by other groups, investigating genomic protection, nearly completing the picture of the Miwi-based transposon silencing mechanism, and proposes that Piwi proteins act in a two-pronged mammalian transposon silencing strategy: one promotes transcriptional repression in the embryo, the other reinforces silencing at the post-transcriptional level after birth, both of which are critical for normal male fertility.

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/111128_1.htm

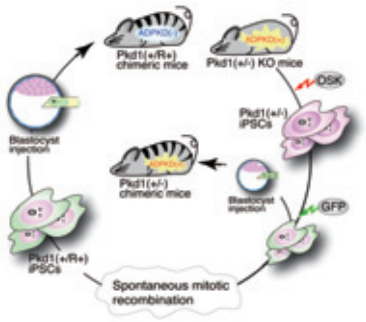
Toward Clinical Application of iPS Cells from Patients with Genetic Disorders

Genome Editing in Pluripotent Stem Cells

Associate Professor Takashi Tada – Institute for Frontier Medical Sciences

Induced pluripotent stem (iPS) cells, which are pluripotent stem cells reprogrammed from individual somatic cells, are anticipated to contribute to regenerative medicine as a cell source for generating replacement cells and tissues. In iPS cells, an epigenotype, but not a genotype, can be reprogrammed into a pluripotent cell type. Therefore, mutations that cause genetic disorders are not restored in iPS cells generated from patients. For therapeutic treatment of genetic disorders with iPS cells, development of a technique of genome editing in disease-specific iPS cells is required.

To demonstrate proof of principle for spontaneous genetic correction of disease-related mutation alleles through mitotic recombination, Associate Prof. Takashi Tada investigated a prevalent inherited disorder, autosomal dominant polycystic kidney disease (ADPKD), which is caused by genetic mutation of the PKD1 in 85% and PKD2 in 15% of cases clinically diagnosed by intrarenal cystogenesis. Large-scale screening for the PKD1 mutation in heterozygous iPS clones demonstrated that restoration of genetic mutation occurred spontaneously through mitotic cell divisions. Genetically restored iPS cells generated no intrarenal cysts, while parental (genetically mutated) iPS cells induced cystogenesis in chimeric mice. The mitotic recombination-mediated genetic correction approach will open a new path to clinical application for human iPS cells that is relevant to patient groups.



Dr. Tada believes that further development of the new technologies and understanding mechanisms involved in epigenetic reprogramming will advance the shift in iPS cell technology application from bench to bed.

www.frontier.kyoto-u.ac.jp/es03/index.html

Genome Features of "Dark-fly"

Molecular Mechanisms Underlying Environmental Adaptation

Research Fellow Naoyuki Fuse – Graduate School of Science

Organisms are remarkably adapted to diverse environments by specialized metabolisms, morphologies or behaviors. How organisms come to possess adaptive traits is a fundamental question for evolutionary biology. Experimental evolution studies have provided insights into the molecular mechanisms underlying environmental adaptation, but were limited mostly to bacteria that carry a small genome. Recently, next-generation sequencing technology has enabled researchers to determine the whole genome sequences of sexual organisms and is beginning to be applied to experimental evolution studies. Research Fellow Naoyuki Fuse and his research team are studying the environmental adaptation using an unusual Drosophila melanogaster line, termed "Dark-fly," which has been maintained in constant dark conditions for 57 years (1400 generations). They have found high fecundity rates of Dark-fly in darkness, and determined the whole genome sequence of Dark-fly using a next-generation sequencer. They have identified many genomic alterations and obtained a list of the potential candidate genes involved in the Dark-fly's traits. These included genes related to detoxification and light perception. Although functional analysis of each mutation remains a future issue, they are able to present a framework for linking genomic alterations to environmental adaptation. This finding was published on the PLoS ONE Website.

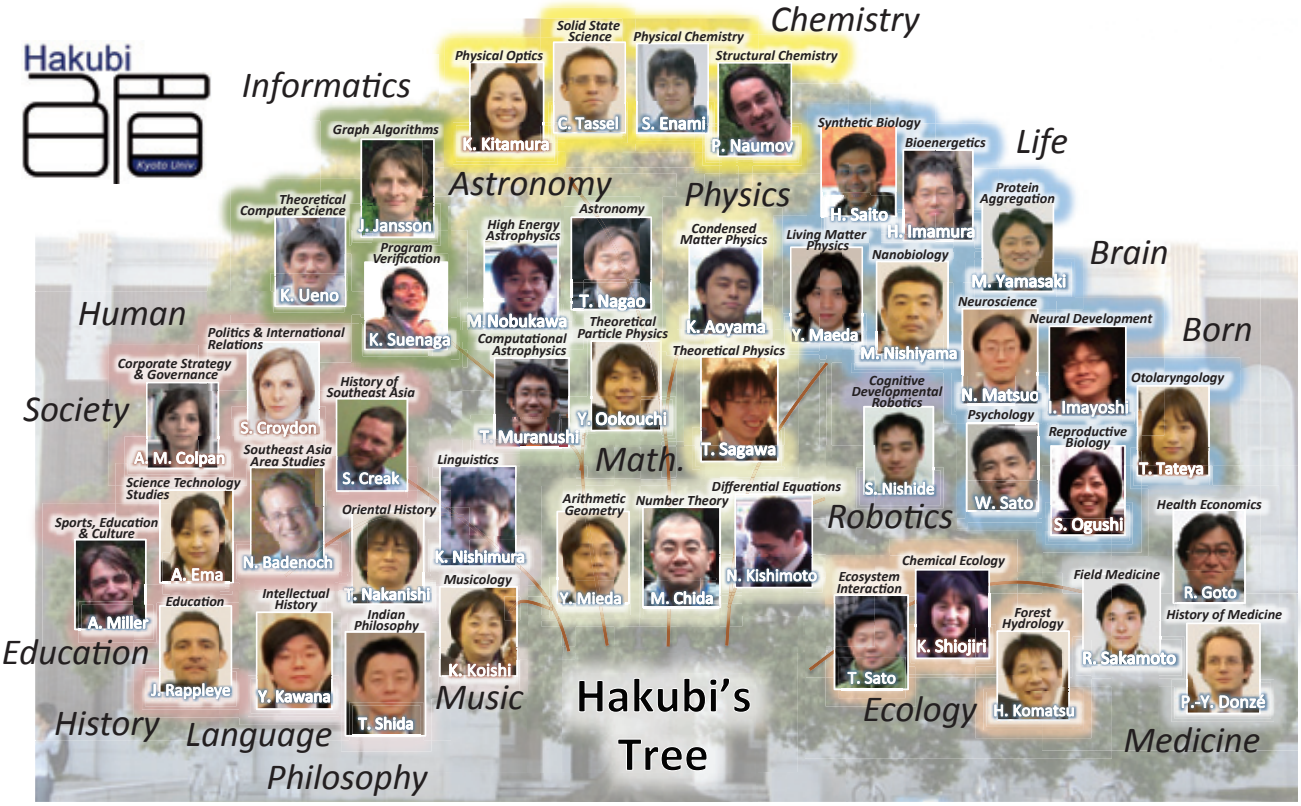
(www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0033288).

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/120315_1.htm

Figure legend:
The Dark-fly [right] looks similar to normal fly [left], but they carry many mutations in their genome.

The Hakubi Project was established by Kyoto University in 2009 to foster outstanding young researchers with the creativity, broad perspectives and flexible mindset needed in this globalized age. The program recruits up to twenty international researchers per year, and gives outstanding scholars the valuable opportunity to devote themselves entirely to their research activities.

Researchers on the Hakubi Project receive a generous annual salary and annual research funding. They are also given a great deal of freedom to focus on their studies. They are not required to perform any administrative or teaching duties and are free to pursue their research at institutions outside of Kyoto University.



Hakubi Researchers as of October 2012

■Employment conditions and affiliation

Hakubi researchers are employed for five years by Kyoto University as associate or assistant professors, during which time they engage in research at their host faculty, graduate school, institute, or research center. They are provided with various forms of support to ensure that they can effectively pursue their research and realize their maximum potential. The logistics of the program are handled by the Hakubi Center for Advanced Research, which provides support for the Hakubi researchers and acts as a liaison between the researchers and the relevant departments of Kyoto University.

■What does Hakubi mean?

The term hakubi literally means "white eyebrows" in Japanese. The project is named after a legend from *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.

■Call for application and screening flow

The Hakubi Project welcomes applications from researchers throughout the world regardless of the applicant's nationality, and is open to any researcher holding a doctoral degree in any academic field (or with equivalent research abilities in any basic or applied studies).

Hakubi researchers are selected based on a comprehensive evaluation of their research history, research proposals, and their prospects for assuming a leadership role in the future. The first screening of applicants is performed by an Expert Committee, composed of Kyoto University professors selected in accordance with the relevant academic fields, which screens the application documents. For the second screening, the Hakuraku Council, consisting of influential intellectuals from within and outside the university, interviews the candidates selected by the Expert Committee. The Steering Committee then makes the final selection of successful applicants, up to a maximum of twenty per year.

Schedule for 2013 Selection

Early March
Opening of Application Period

Middle/Late March
Application Orientation in Kyoto and Tokyo

Early May
Closing of Application Period

May to July
First Screening by Expert Committee

Late August
Second Screening by Hakuraku Council (Interview in Japanese/English)

September
Selection of Successful Applicants by Steering Committee

October
Publication of Nominated Researchers to be employed from April 1, 2014

■Number of Total and Successful Applicants

	Total No. of Applicants	Successful Applicants	Competition Rate
FY 2010	588	18	32.7 times
FY 2011	517	19	27.2 times
FY 2012	416	19	21.9 times
FY 2013	655	20	32.8 times

Ratio of Total Applicants*	FY 2010	FY 2011	FY 2012	FY 2013
Male : Female (%)	77.9 : 22.1 (77.8 : 22.2)	81.4 : 18.6 (89.5 : 10.5)	80.5 : 19.5 (73.7 : 26.3)	78.0 :22.0 (85.0 : 15.0)
Humanity & Social Sciences : Natural Sciences (%)	33.3 : 66.7 (33.3 : 66.7)	27.3 : 72.7 (31.6 : 68.4)	34.4 : 65.6 (36.8 : 63.2)	45.8 : 54.2 (50.0 : 50.0)
Kyoto U. Affiliates : Others (%)	38.4 : 61.6 (44.4 : 55.6)	35.4 : 64.6 (52.6 : 47.4)	31.5 : 68.5 (36.8 : 63.2)	22.0 : 78.0 (45.0 : 55.0)
Address Japan : Other Countries (%)	81.0 : 19.0 (83.3 : 16.7)	79.5 : 20.5 (84.2 : 15.8)	82.2 : 17.8 (94.7 : 5.3)	65.2 : 34.8 (75.0 : 25.0)

* Figures in parentheses indicate the ratios for successful applicants.

■Place for Research Activities

Individual researchers should make their own arrangements for a "host" within Kyoto University that is willing to provide suitable research facilities. The arrangement is not necessarily a prerequisite for application. The Program Manager can provide assistance in arranging appropriate facilities, based on consultation of needs and interests.

Stay tuned for the call next spring

Call for applications will open for the fifth time in March 2013.

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

Kyoto University in a Nutshell

Mission Statement

Our mission is to sustain and develop our historical commitment to academic freedom and to pursue harmonious coexistence within the human and ecological community on this planet.

Foundation

- 18□7
- □apan□s second oldest national university

Facilities

- □ Campuses located in □yoto City
- 10 Faculties
- 17 Graduate Schools
- 1□ Research Institutes
- □0 Research and Educational Centers
- □1 University Establishments in □apan
- □8 Overseas Of□ces and Facilities

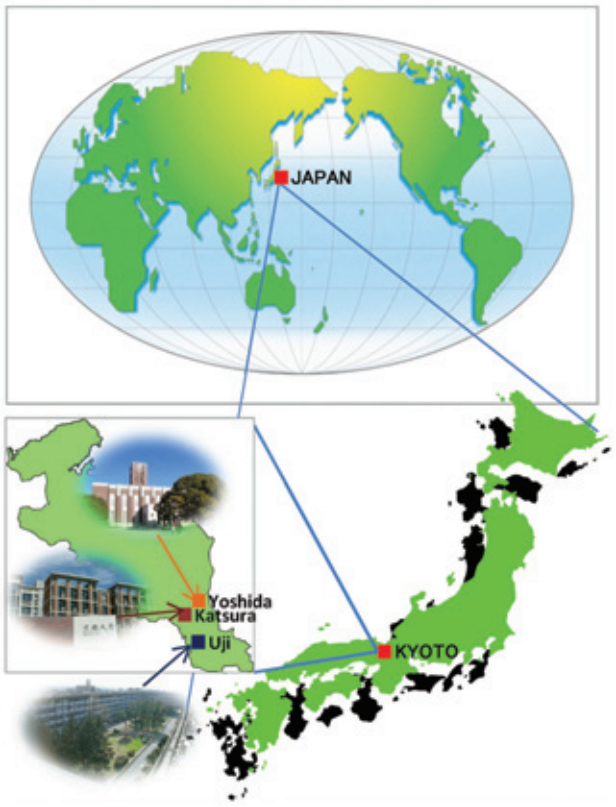
Faculty, Staff & Students

as of May □011

- □□8□&□ured Faculty
- □□□80 □on-teaching Staff
- 1□□□□7 Undergraduates
- □□□8□ Graduate Students
- 1□□□8 Students from abroad
- □□□□□ Researchers from abroad

□April □010-March □01□

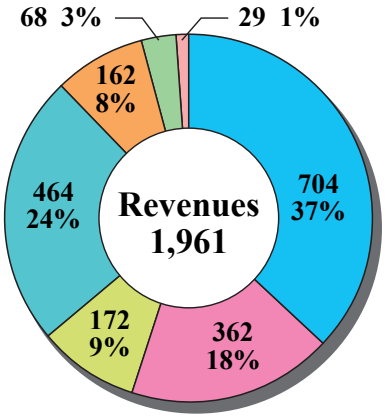
Location



Budget

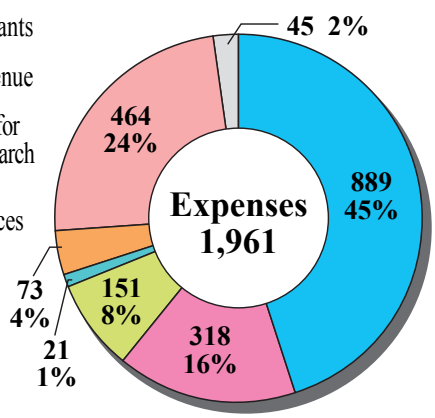
Unit: U.S. million dollars
US$1=¥80.77

Revenues in Fiscal Year 2011



- University Grants
- Hospital Revenue
- Grants-in-Aid for Scientific Research
- Funding from External Sources
- Tuition Fees
- Facilities Subsidies
- Other

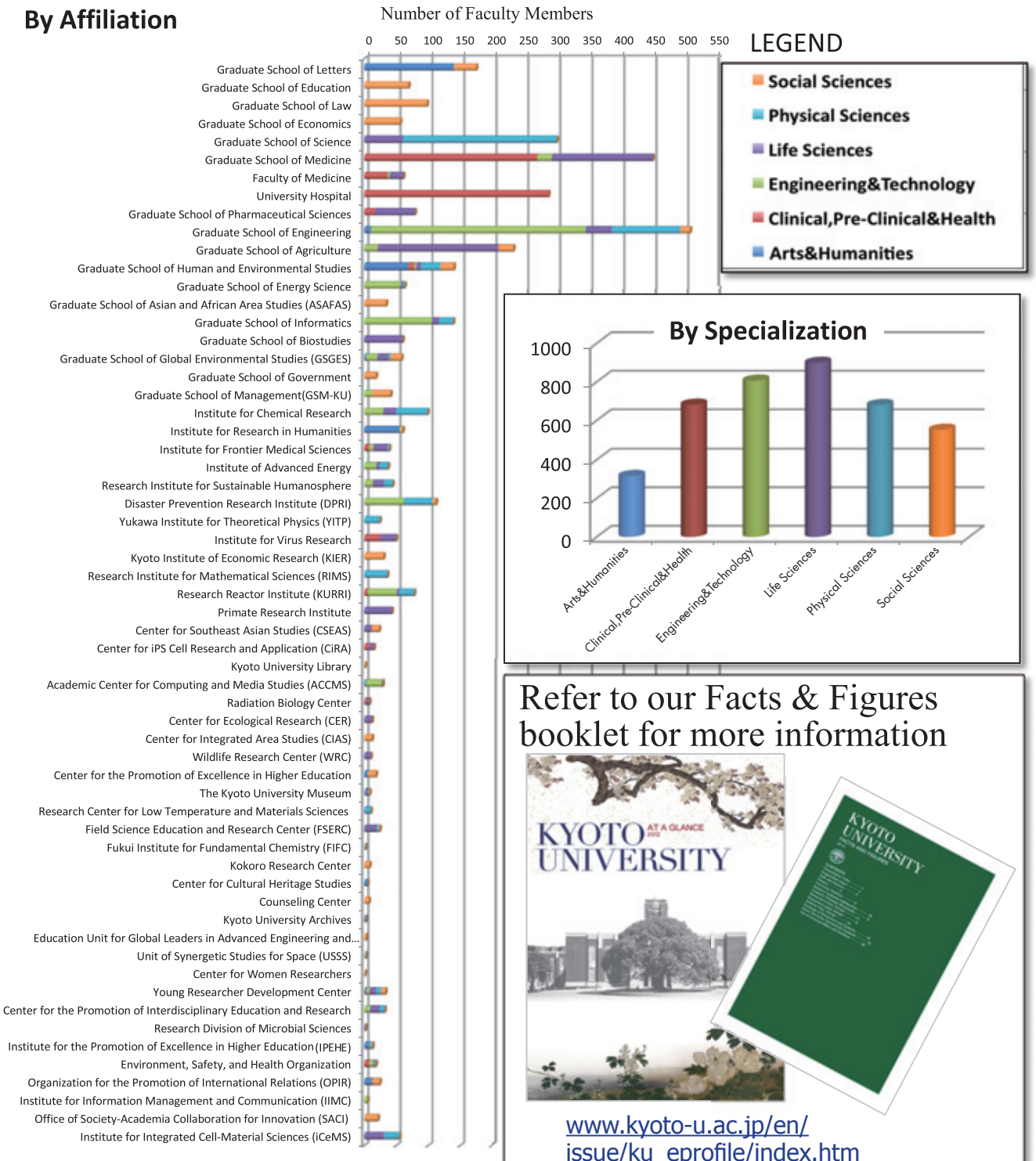
Expenses in Fiscal Year 2011



- Instruction and Research Cost
- Hospital Expenditures
- Grants-in-Aid for Scientific Research
- Balance brought forward and Member of a Research Project
- Facilities Maintenance Cost
- Costs Incurred by projects with Industries
- Payment Forward Long-term Loans

Diversity of Research at Kyoto University

By Affiliation

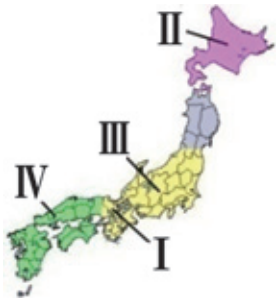


Refer to our Facts & Figures booklet for more information

www.kyoto-u.ac.jp/en/issue/ku_eprofile/index.htm

* Based on the data in 2011.
* Non-permanent positions multiplied by 0.3 (IPEHE shows only permanent positions)

University Establishments in Japan



Kyoto University operates a wide variety of facilities located throughout the nation, ranging from field stations and observatories to region-based research laboratories. Each of them serves as unique and indispensable resources that support the research activities of Kyoto University. The university is particularly renowned for its rich achievements stemming from its wide range of fieldwork.

Area Ⅰ [Kyoto Prefecture]

1. Maizuru Fisherise Research Station (F.S.E.R.C.)
2. Livestock Farm (Agr.)
3. Ashiu Forest Research Station (F.S.E.R.C.)
4. Kamigamo Experimental Station (F.S.E.R.C)
5. Kazan Observatory (Sci.)
6. Research Center for Fluvial and Coastal Disasters (D.P.R.C.)
7. Laboratory of Crop Evolution (Agr.)

Abbreviations

D.P.R.I. : Disaster Prevention Research Institute
Sci. : Graduate School of Science
Eng. : Graduate School of Engineering
R.I.S.H. : Research Institute for Sustainable Humanosphere
Agr. : Graduate School of Agriculture
F.S.E.R.C. : Field Science Education and Research Center
W.R.C. : Wildlife Research Center

Area Ⅱ [Hokkaido Prefecture]

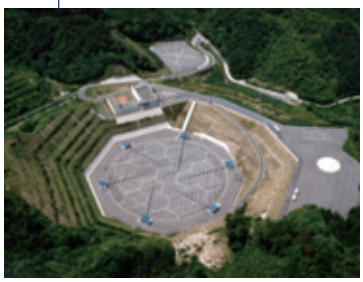
1. Hokkaido Forest Research Station, Shibecha Branch, Hokkaido
2. Hokkaido Forest Research Station, Shiranuka Branch, Hokkaido (F.S.E.R.C.)

Branch Office in Tokyo

The Tokyo Office offers meeting spaces in a central location for students, alumni, professors and others of KU to conduct constructive networking activities for the expansion of the university's academic activities.

Area Ⅲ

3. Ogata Wave Observatory, Niigata (D.P.R.I.)
4. Kiso Biological Research Institute, Fukushima, Nagano (Sci.)
5. Kamitakara Earthquake Prediction Observatory, Gifu(D.P.R.I.)
6. Hodaka Sedimentation Observatory, Gifu (D.P.R.I.)
7. Hida Observatory, Kamitakara, Gifu (Sci.)
8. Hokuriku Earthquake Prediction Observatory, Fukui (D.P.R.I.)
9. Primate Research Institute, Inuyama, Aichi
10. Center for Ecological Research, Otsu, Shiga
11. Research Center for Environmental Quality Control (Eng.)
12. Shigaraki MU Observatory (R.I.S.H)
13. Osakayama Earthquake Prediction Observatory, Otsu, Shiga (D.P.R.I.)
14. Abuyama Earthquake Prediction Observatory, Takatsuki, Osaka (D.P.R.I.)
15. Experimental Farm, Takatsuki, Osaka (Agr.)
16. Research Reactor Institute, Kumatori, Osaka
17. Donzurubo Earthquake Prediction Observatory, Nara (D.P.R.I.)
18. Ouda Station of Department of Astronomy, Ouda, Nara (Sci.)
19. Kii-Oshima Research Station, Wakayama (F.S.E.R.C.)
20. Shinomisaki Wind Effect Laboratory, Wakayama (D.P.R.I.)
21. Shirahama Oceanographic Observatory, Wakayama (D.P.R.I.)
22. Seto Marine Biological Laboratory, Wakayama (F.S.E.R.C.)
23. Wakayama Forest Research Station, Wakayama (F.S.E.R.C.)



Area view of the middle and upper atmosphere radar (MU radar)

Area Ⅳ

24. Tottori Earthquake Prediction Observatory, Tottori (D.P.R.I.)
25. Tokuyama Experimental Station, Tokuyama, Yamaguchi (F.S.E.R.C.)
26. Tokushima Earthquake Prediction Observatory, Tokushima (D.P.R.I.)
27. Tokushima Landslide Observatory, Tokushima (D.P.R.I.)
28. Beppu Geothermal Research Laboratory, Beppu, Oita (Sci.)
29. Aso Volcanological Laboratory, Aso, Kumamoto (Sci.)
30. Chimpanzee Sanctuary Uto, Kumamoto (W.R.C)
31. Miyazaki Earthquake Prediction Observatory, Miyazaki (D.P.R.I.)
32. Koshima Field-Station, Koshima, Miyazaki (P.R.I.)
33. Sakurajima Geothermal Research Center, Kagoshima (D.P.R.I.)
34. Yakushima Field-Station, Kamiyakucho, Kagoshima (P.R.I.)

Areal view of Seto Marine Biological Laboratory

Dr. Michiaki Mishima appointed Executive Vice-President for International Affairs and Hospital Administration

Dr. Michiaki Mishima was appointed executive vice-president for international affairs and hospital administration of Kyoto University on October 1, 2012. In this capacity Dr. Mishima will oversee the university's increasingly diverse activities relating to international affairs and student exchange, in addition to continuing his duties as director of the Kyoto University Hospital.

CURRICULUM VITAE

Mar. 1977	Graduated from the Faculty of Medicine, Kyoto University
Apr. 2001–Present:	Professor and Chairman, Department of Respiratory Medicine, Graduate School of Medicine, Kyoto University
Apr. 2011–Present:	Director, Kyoto University Hospital
Oct. 2012–Present:	Executive Vice-President for International Affairs and Hospital Administration, Kyoto University

Michiaki Mishima,
M.D., Ph.D.
Executive Vice-President for International Affairs and Hospital Administration
Director, Kyoto University Hospital
Professor, Graduate School of Medicine, Kyoto University

The Organization for the Promotion of International Relations (OPIR)

The OPIR coordinates and manages Kyoto University's international cooperation and exchange activities at the university-wide level. Serving as the university's international strategy headquarters, it seeks to maximize the mutual benefits of international cooperation between Kyoto University and its partners.

Director-General
Junichi Mori

Main Activities:

◆Information gathering and planning for the promotion of international relations at the university-wide level
◆Expansion of multi-faceted academic exchange through involvement with international university alliances
◆Improvement of infrastructure for the recruitment of international students and researchers
◆Cultivation of administrative skills for international exchange activities and organizational enhancement
www.opir.kyoto-u.ac.jp/e/index.html

Partner Universities and Consortia

Kyoto University has concluded 93 university-level, and over 500 faculty-level, exchange and cooperation agreements with leading universities, institutions and academic associations around the world. Through those agreements, the university is engaged in numerous collaborative research and academic exchange programs in various fields.

www.kyoto-u.ac.jp/en/research/international/agreement/index.htm

Recent Activities

◆From 15–20 April, 2012, a delegation from Kyoto University visited Riyadh to attend the International Exhibition and Conference on Higher Education, an event hosted by the Saudi Arabian Ministry of Education to promote academic cooperation and student mobility. In addition to promoting Kyoto University to young Saudi Arabian students, the delegation had productive meetings to establish cooperative partnerships with several leading institutions, including Salman bin Abdulaziz University, and King Fahd University of Petroleum and Minerals and the affiliated Saudi Aramco oil company.
www.kyoto-u.ac.jp/en/news_data/h/h1/news7/2012/120420_1.htm

◆On May 24, 2012 Kyoto University welcomed a delegation headed by H.E. Mr. Guiren Yuan, Minister of Education of the People's Republic of China. Minister Yuan met with President Hiroshi Matsumoto and several executive staff members to discuss the strengthening of ties between Kyoto University and academic institutions in China.

www.kyoto-u.ac.jp/en/news_data/h/h1/news7/2012/120524_1.htm

SACI Office of Society-Academia Collaboration for Innovation

Missions :

- **To promote collaborative research between academia, industry and the government**
- **To support start-up businesses by researchers and students**
- **To manage and utilize the university's intellectual properties**

Director
Hidetoshi Kotera

SACI Website Redesigned !

The site aims to provide a one-stop shop for companies that are interested in collaboration with Kyoto University. Through this site, you can acquire up-to-date information on technologies developed by Kyoto University.

Visit:
www.saci.kyoto-u.ac.jp/en

Videos of one-of-a-kind technologies offered by Kyoto University.

Look up technologies by category.

Check the latest technologies.

Look up technologies by keyword.

Kyoto University Research Administration Office (KURA)

As part of a new national government initiative, the Kyoto University Research Administration Office (KURA) was officially launched in April 2012 as an organization to provide consistent research support for project planning, obtaining research funds, project execution and public relations. KURA is intended to ease the non-research related burden (such as administrative work) imposed on researchers by providing a well-organized research support network. To achieve that aim, KURA networks and collaborates with existing research support offices at Kyoto University.

www.kura.kyoto-u.ac.jp/en/

Vision

To contribute to the generation of world-class knowledge by collaborating with researchers in accordance with Kyoto University's mission, and to be a pioneering model for university research administration in Japan.

Mission

■ **Facilitating research activities**

To support the development of an infrastructure for research promotion utilizing diverse research resources at Kyoto University.

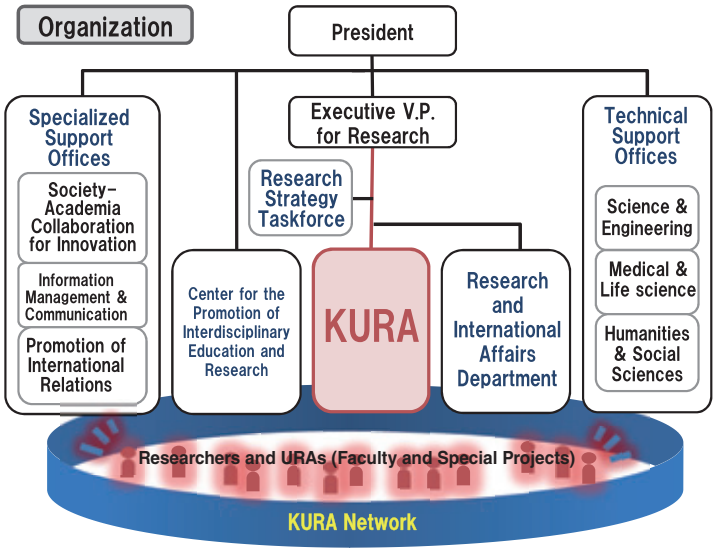
To create a support system to obtain external research funds.

■ **Disseminating research achievements society**

To form a hub for mutual communication between researchers and society.

■ **Creating an infrastructure for effective support**

To create a research administration network which resonates with the diverse members and fields of knowledge at Kyoto University.

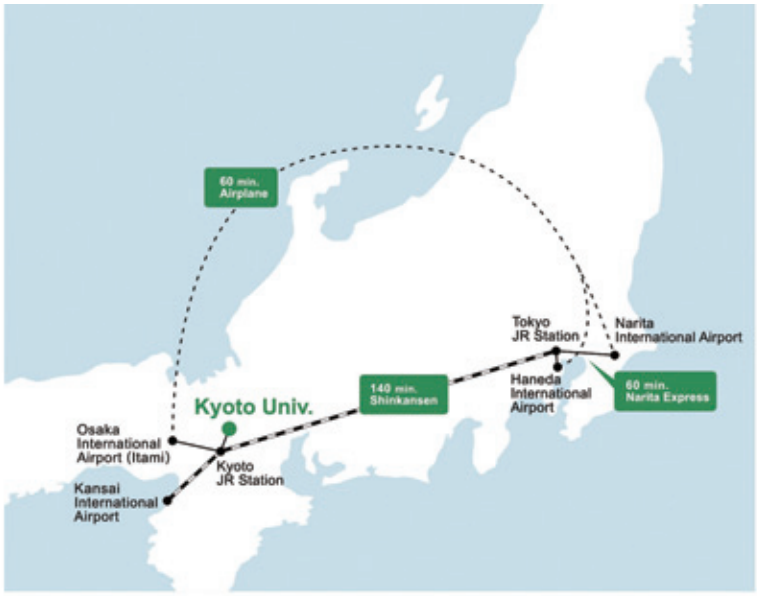


KURA collaborates with the faculties, institutes and research centers of Kyoto University, as well as with external national and international research organizations, including those in the private sector. Through these activities, KURA aims to form a robust prototype for an effective university research administration system—a concept which is not currently well recognized in Japan, and to develop training programs for university research administrators.

As of April 1, 2012, the KURA staff consists of three senior research administrators, five research administrators and three administrators. The office is located on the Yoshida Campus.

Photo: The KURA staff with President Hiroshi Matsumoto [4th from left] and Executive V.P. Kiyoshi Yoshikawa[3rd from left]

Access to Kyoto University



Access to Kyoto Station from Kansai International Airport

The following is a guide to transportation options from Kansai International Airport to JR (Japan Railway) Kyoto Station. Other methods include shared shuttle taxis (fare required) that take each passenger directly to their desired destination.

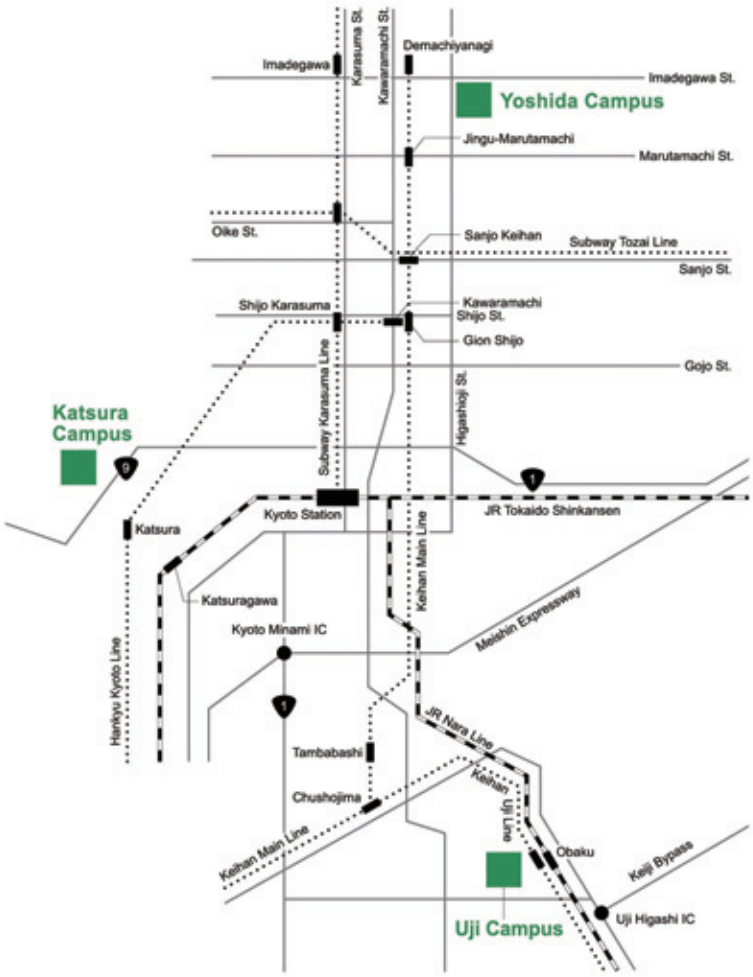
1) Train

JR Airport Express "Haruka"

Kansai International Airport → About 75 min. → JR Kyoto Station

2) Airport Limousine Bus

Kansai International Airport → About 105 min. → JR Kyoto Station



Transportation to Campuses

Yoshida Campus

JR Kyoto Station → City Bus: About 30 min. (*No. 206) Get off at "Kyodai Seimon-mae" / Taxi: About 20 min. → Yoshida Campus

*Bound for Kitaoji Bus Terminal via Higashiyama Street.

Uji Campus

JR Kyoto Station → Local Train: About 20 ~ 25min. JR Nara Line "Obaku" → Uji Campus

Katsura Campus

Hankyu Railway Katsura Station → Keihan Kyoto Kotsu Bus (No. 20 or 20B) City Bus (West No. 6) Get off at "Kyodai Katsura Campus-mae" / Taxi: About 10 min. → Katsura Campus

General Contact Information

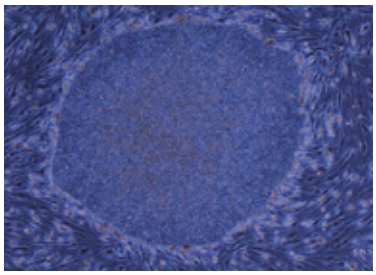
Kyoto University
Yoshida-Honmachi, Sakyo-ku
Kyoto, JAPAN 606-8501
www.kyoto-u.ac.jp

Students:
Foreign Student Division
Tel: +81-75-753-2543 Fax: +81-75-753-2562
E-mail: ryugak78@mail.adm.kyoto-u.ac.jp

Researchers:
International Affairs Division
Tel: +81-75-753-2047 Fax: +81-75-753-2042
E-mail: koryu52@mail.adm.kyoto-u.ac.jp (visitation support)
research_promotion@mail2.adm.kyoto-u.ac.jp (research collaboration support)

Businesses:
Office of Society-Academia Collaboration for Innovation
Tel: +81-75-753-5534 Fax: +81-75-753-5538
E-mail: info@saci.kyoto-u.ac.jp

For inquiries regarding this publication:
Research and International Affairs Department
E-mail: research_activities@mail2.adm.kyoto-u.ac.jp



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