

# Cutting-Edge Research in a Broad Range of Fields

Kyoto University is known for the quality and diversity of its research. Each issue of Research Activities can only highlight a small selection of those endeavors, but we hope to convey an impression of the university's rich academic milieu.

## MED 4D Visualization of Skin

*Two-photon microscopy visualize the inside of skin without invasion.*

Diagnostic and experimental tools to understand the pathophysiology of skin include the histology of skin biopsy samples thus far. With a two-photon microscopy system, Dr. Kenji Kabashima and his colleagues have succeeded non-invasively visualizing skin. It is now possible to evaluate skin inflammation via the visualization over time of skin blood vessels in a steady state and in inflammation. The system also enables the time-lapse analysis of skin immune responses by visualizing immune cells in murine skin. Moreover, Dr. Kabashima's group is currently working on the development of a non-invasive system to diagnose human skin diseases.

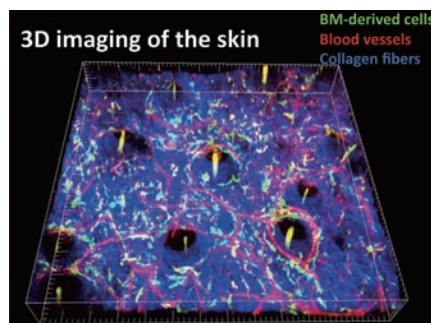


**Dr. Kenji Kabashima**

Associate Professor, Graduate School of Medicine

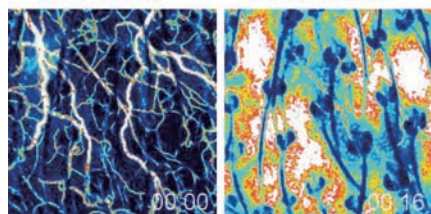
[www.kenjikabashima.com/blog/](http://www.kenjikabashima.com/blog/)

[www.kuhp.kyoto-u.ac.jp/~skin/](http://www.kuhp.kyoto-u.ac.jp/~skin/)



Visualization of blood vessels

Vascular leakage in inflammation



## MATH Something May Appear from Nothing...

*Noisy evolution with trivial remote past may involve nontrivial randomness.*

A noisy evolution may be described in a mathematical formulation as a stochastic equation with a time parameter. It is quite natural that the solution should involve the evolutionary noise<sup>\*1</sup>. The surprising fact is that the solution sometimes involves a nontrivial randomness which exists at any time and is independent of the evolutionary noise, although the remote past is trivial<sup>\*2</sup>. This is as if something had existed since the remote past where nothing should exist!

The research originates from Tsirelson's pioneering example of a stochastic differential equation<sup>\*3</sup>. Yor's generalization revealed the fact that the extra randomness is uniform<sup>\*4</sup> on a subgroup when the state space is a group<sup>\*5</sup>. Dr. Kouji Yano studied the equation whose state space has a priori no group structure and proved that the extra randomness is still uniform on a certain group which is hidden behind the model. Dr. Yano seeks to acquire a thorough understanding of the mechanism which causes the appearance of such an extra randomness.



**Dr. Kouji Yano**

Associate Professor, Graduate School of Science

[www.math.kyoto-u.ac.jp/~kyano/](http://www.math.kyoto-u.ac.jp/~kyano/)

### Noisy evolution

$$X_t = N_t X_{t-1}$$

$t = -\infty$ ; the remote past

### Solution

$$X_t = F_t(N, \xi)$$

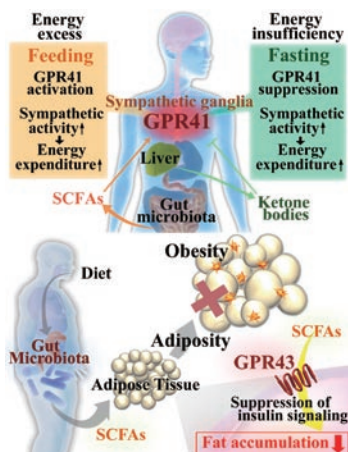
This  $\xi$  is of my interest to me !!



<sup>\*1</sup> [noise] means a random perturbation. <sup>\*2</sup> [trivial] is a mathematical term which roughly means no information. <sup>\*3</sup> [stochastic differential equation] its mathematical foundation was established by Dr. Kiyosi Itô (1915-2008), who was the director of RIMS during 1976-1979. <sup>\*4</sup> [uniform] is a mathematical term which means invariance of the distributions with respect to multiplications. <sup>\*5</sup> [group] is a mathematical term which means a set equipped with a multiplication structure.

## BIOL Diet, Gut Microbiota, and Obesity

*Host energy regulation by short-chain fatty acids receptors through diet and gut microbiota.*



Food intake regulates energy balance and its dysregulation leads to metabolic disorder, such as obesity and diabetes. During feeding, gut microbiota affects host nutrient acquisition and energy regulation and can influence the development of obesity and diabetes. Short-chain fatty acids (SCFAs), produced by the gut microbial fermentation of dietary fiber, are recognized not only as host energy sources but also as signal transduction molecules via G-protein coupled receptor GPR41 and GPR43. Dr. Ikuo Kimura and his colleagues discovered that these SCFAs receptors are related to host energy homeostasis, i.e., GPR41 regulates sympathetic activity and GPR43 regulates adipose-insulin signaling by sensing SCFAs. These further studies are expected to represent a central mechanism to account for the effects of diet and probiotics on bodily homeostasis and suggest a promising therapeutic target for the treatment of metabolic syndromes.

**Dr. Ikuo Kimura**

Assistant Professor, Graduate School of Pharmaceutical Sciences  
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## BIOL Biological Membrane Bending

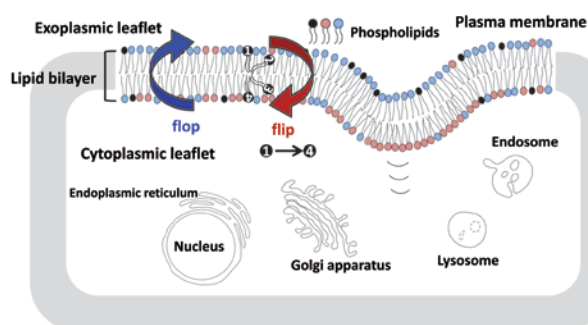
*Changes in lipid composition across lipid bilayers play a key role in membrane remodeling.*

Eukaryotic cells require dynamic membrane shape changes in many cellular activities including intracellular trafficking, cell migration, cell division, invasion, and neurite outgrowth. Biological membranes are composed of a lipid bilayer, and local changes in lipid composition between the two leaflets allow membrane deformation. Dr. Hye-Won Shin and her colleagues are seeking answers to the question of how changes in lipid composition (lipid flip-flop) contribute to the cellular activities accompanying membrane deformation. They have focused in particular on flippases (P4-ATPases) which translocate lipids across the lipid bilayers. The study is expected to establish a new concept for a functional association of local changes in lipid composition in various cellular activities.



**Dr. Hye-Won Shin**

Associate Professor, Graduate School of  
Pharmaceutical Sciences  
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## LAW For Better Legislation

*Role of the constitutional court in the legislative process.*

It is generally said that the role of the constitutional court's statute review is to ensure the protection of fundamental human rights. However, this conception of the constitutional court's review seems to be one-sided. In fact, more attention should be paid to interaction between the cabinet, parliament, and constitutional courts produce better

legislation and, moreover, better government. From this perspective, Prof. Masahiro Sogabe studies on the French Constitutional Council (Conseil Constitutionnel). The Council is an exceptional constitutional court in that it rules on whether statutes conform to the Constitution, after they are passed by Parliament, but before, they come into force. This function is conducive to the interaction between courts described above.



The Constitutional council of the French Republic (from their web site)

**Prof. Masahiro Sogabe**

Professor of Graduate School of Law

lawschool.law.kyoto-u.ac.jp/teacher/profile/law/sogabe.html



## ELECTROCHEMISTRY Research for Fukushima Reconstruction with Advanced Technology

*Use of UFB water for the remediation of radioactive contamination and horticultural applications.*

It has recently been found that ultra fine bubbles (UFB) can be applied in various fields. Dr. Yoshikatsu Ueda and Dr. Yomei Tokuda reported the effectiveness of water containing UFB (approx. 100 nm diameter) in removing radioactive

cesium from soil and gravel conglomerate and nonwoven cotton. The method of radioactive contamination removal using UFB water is currently under trial in Fukushima. Dr. Ueda and Dr. Tokuda have also investigated the effect of UFB water in retaining the freshness of cut flowers such as gentiana, and its effect on their coloring. The detailed mechanism of the UFB's function in these applications is yet not well understood, but the relevance of ions (proton ( $H^+$ ) and hydroxide ( $OH^-$ ) ion) in solution is thought to be a key factor.



Coloring effects of UFB and purified water on gentiana  
a comparison of the coloring agent, diluted with UFB water and purified water.

**Dr. Yoshikatsu Ueda (left)**

*Assistant professor, Research Institute for Sustainable Humanosphere*  
[www.rish.kyoto-u.ac.jp/space/people/yueda](http://www.rish.kyoto-u.ac.jp/space/people/yueda)

**Dr. Yomei Tokuda (right)**

*Associate professor, Institute for Chemical Research*  
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## LAW Exporting Japanese Criminal Law

*An excellent fusion of different justice systems around the world.*

It has been common practice in Japan to import and adopt foreign legal systems. Beginning with Chinese criminal law, many elements of laws from many different countries, including England, France, and Germany, were introduced into the Japanese legal system during the Meiji modernization period. After World War II, American law greatly influenced the establishment of the Constitution

and criminal procedure law. That history has developed the uniquely mixed legal system of Japan. Today, the importance of such a mixed system is becoming more apparent as a fusion of different legal systems from around the world is required for international criminal procedures involving multiple countries. Further research and development of Japanese criminal law is expected to contribute to the improvement of the international justice system.



Cour  
Pénale  
Internationale

International  
Criminal  
Court



**Prof. Kanako Takayama**

*Professor, Graduate School of Law*  
[www.kt.rim.or.jp/~k-taka/eindex.html](http://www.kt.rim.or.jp/~k-taka/eindex.html)



## Students Also Drive Research

*KU students embark on promising international careers.*

Kyoto University's cutting-edge research outcomes are not only produced by the university's dedicated researchers—our students also play a role. The intelligence, creativity, and originality of Kyoto University students has been acknowledged in the form of several international academic awards. In this feature we will introduce a small selection of those awards. We look forward to following the development of our students as they embark on promising international careers!





## CHEM Chemically-Inspired Biomaterials

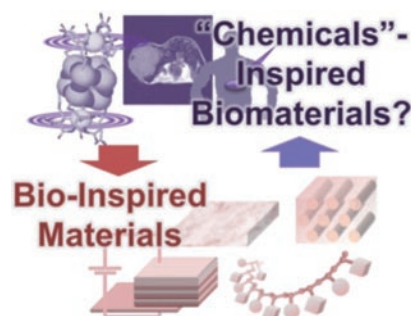
*New design strategy for biomaterials based on the chemistry in artificial materials or devices.*

By using natural materials or mimicking mechanisms in nature, functionalized materials have been developed, which are known as bio-inspired materials. However, little research has been undertaken regarding the reverse process. The studies of Dr. Kazuo Tanaka and his colleagues focus on polymers to develop thermally-resistant materials or opto-electric devices. By applying the chemical principles of artificial products unrelated to biology, they have recently succeeded in developing unique biomaterials, such as ultra-sensitive MRI contrast agents developed by applying a function of rigid molecules used for reinforcing the thermal stability of plastics. The concept of “chemically”-inspired biomaterials is anticipated to contribute to the development of new functions for and improve the properties of existing devices.



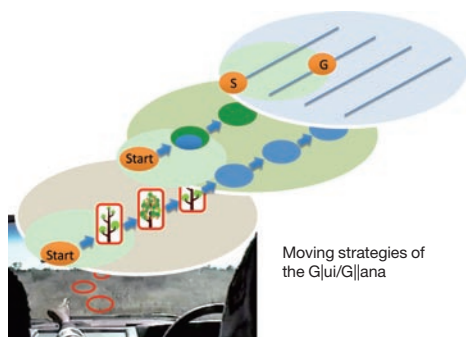
**Dr. Kazuo Tanaka**

Assistant Professor, Graduate School of Engineering  
chujo.synchem.kyoto-u.ac.jp/en/



## ANTHROP Desert Topography

*Wayfinding practices of the San of the Central Kalahari (G|ui / G||ana).*



Moving strategies of the G|ui/G||ana

The San are known to be indigenous to southern Africa. Among the groups of San, the G|ui and the G||ana live in the central part of the Kalahari Desert. Their spatial cognition is complemented by a multi-scaled integration of folk knowledge, through which they transform “nature” into “culture.” Dr. Takada has clarified that the key points regarding their moving strategies are (1) a keen perception of ground conditions to avoid obstacles, such as burrows of animals and thorny plants; (2) an immense knowledge of specific trees, used as landmarks in the bushveld; (3) an understanding of woodlands and basins as nodes in the environment (these areas provide valuable resources for the G|ui and G||ana and serve as campsites during their nomadic travels); and (4) a conceptualization

of sequences of woodlands and/or basins with reference to ecological features that are sometimes employed as a route for nomadic movement.

**Dr. Akira Takada**

Associate Professor, Graduate School for Asian and African Area Studies  
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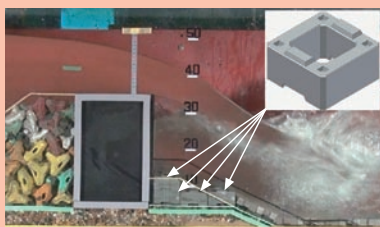


## Kyoto University Researcher Awarded De Paepe-Willems Award 2013 by PIANC

The De Paepe-Willems Award is presented annually by the World Association for Waterborne Transport Infrastructure (PIANC) for the best technical paper by a young researcher. On January 31, the 2013 award was presented to Mr. Hiroshi Matsushita, a second-year doctoral student in the Prof. Hiraishi laboratory of the Disaster Prevention Research Institute (DPRI) for his paper titled Breakwater Reinforcement Method against Large Tsunami. This is the first time that the award has been presented to a student from the Asian region. Mr. Matsushita's study introduces a method of reinforcing breakwaters against large tsunamis by installing newly developed blocks behind the breakwaters on the harbor side.

**Mr. Hiroshi Matsushita**

Chief Engineer, Nikken Kogaku Co., Ltd. / Researcher, Disaster Prevention Research Institute  
www.dpri.kyoto-u.ac.jp/~refcd/cse/lab/eng/indexeng.html



A hydraulic model experiment demonstrating the award winning research.



## INFORMAT Youth Mediated Communication for Vietnamese Agriculture

*Utilizing the Language Grid for Japanese-Vietnamese Knowledge Communication.*

Youth Mediated Communication (YMC) is an agricultural support project, in cooperation with the NPO Pangaea, the University of Tokyo, and the Vietnamese Government. Since the literacy rate of farmers in Vietnam is fairly low, the project trains Vietnamese youths to serve as communication mediators between the farmers and Japanese agricultural experts. The youths receive questions from Vietnamese farmers, communicate with Japanese experts via the YMC system, and then transfer agricultural knowledge from the experts to the farmers. In addition, they collect daily field data (e.g. temperature, humidity, pictures, etc.) and send them to the Japanese experts. The YMC

system is a multi-language online Social network service (SNS) built on the top of the Language Grid, which has been operated by Kyoto University since 1997 in cooperation with 140 research organizations worldwide.



**Dr. Toru Ishida**

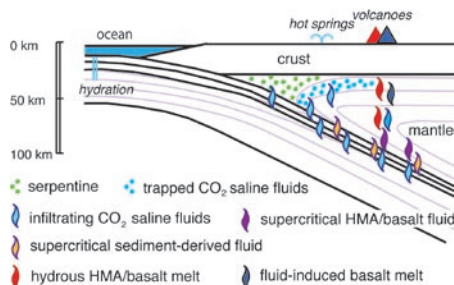
Professor, Department of Social Informatics, Graduate School of Informatics, Kyoto University  
[www.ai.soc.i.kyoto-u.ac.jp/communication\\_design.html](http://www.ai.soc.i.kyoto-u.ac.jp/communication_design.html)



## GEO Sea Water Producing Salty Hot Springs and Volcanoes

*Mantle wedge infiltrated with saline fluids from subducting plate.*

Subducting plates carry H<sub>2</sub>O into the mantle beneath island arcs like Japan and the Philippines. Earthquakes, hot springs, and volcanoes are caused by the addition of the H<sub>2</sub>O fluids. Dr. Kawamoto found saline fluid inclusions in crystalline mantle rocks collected from the 1991 Pinatubo eruption. They contain 5.1 wt. % NaCl, which is a little saltier than sea water (3.5 wt. %). His observation suggests the hydration of the mantle by sea water dehydrated from subducting plates.



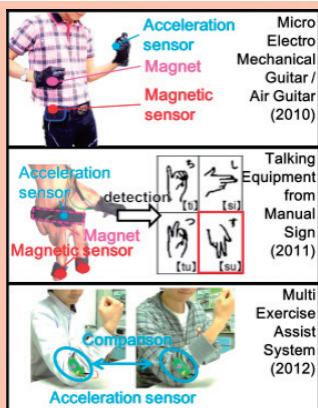
Such saline fluids dehydrated in shallower depths return to salty hot springs such as Arima, Takarazuka, and Shirahama, which are located away from volcanoes. At greater depths, they reduce the melting temperature of mantle to produce magmas. When you cook barbecue on a lava plate, you do not need much salt.



**Dr. Tatsuhiko Kawamoto**

Assistant Professor, Graduate School of Science

[www.vgs.kyoto-u.ac.jp/InetHome/kawamoto/default-E.htm](http://www.vgs.kyoto-u.ac.jp/InetHome/kawamoto/default-E.htm)



## The Success of Team TBT in iCAN

**Team TBT The 2012 Team: Atsushi Nakano, Junya Suzuki, Naoyuki Tamura, Daimon Matsui, Daisuke Takagi**

The International Contest of Applications in Nano/Micro Technologies (iCAN) aims to promote the development of applications using MEMS (Micro Electro Mechanical System) sensors. Team TBT, composed of students from the Nano/Micro System Laboratory, has participated in the contest three times. Their entries include an innovative musical instrument (2010), a translator which converts finger writing into voice (2011), and a device to assist motion copying in sports and rehabilitation using ultra-compact acceleration and magnetic sensors (2012). Their prototypes for these inventions were presented at the iCAN contest, winning them 3<sup>rd</sup> (2010), 1<sup>st</sup> (2011), and 2<sup>nd</sup> (2012) prizes respectively.

**Mr. Atsushi Nakano**

Department of Micro Engineering, Graduate School of Engineering

[www.nms.me.kyoto-u.ac.jp/](http://www.nms.me.kyoto-u.ac.jp/) (Lab.'s website) [www.ican-contest.org/index.html](http://www.ican-contest.org/index.html) (iCAN website)



## EQ-ENG Toward Reducing Deaths Caused by Earthquakes

*Development of a numerical analysis method for predicting collapse behavior of structures during earthquakes.*

Catastrophic earthquakes are responsible for nearly 60% of casualties from natural disasters in the world. The principal cause of death is the collapse of buildings, accounting for about 75% of earthquake fatalities over the last century. In earthquake-prone developing countries, there are many masonry buildings with low earthquake-resistance. These buildings have been found to collapse even at low intensities of ground motion and, worse still, collapse very rapidly at high intensities. In order to reduce the number of casualties attributed to earthquakes in those countries, it is necessary to improve the earthquake resistance of these primarily weak masonry buildings. However, knowledge is still limited as to how buildings collapse, and how earthquake resistance can be effectively improved.

Against this background, Dr. Furukawa has developed a numerical analysis method which can handle a series of seismic behaviors—from elastic to collapse. Her research involves evaluating the seismic resistance of masonry structures overseas through on-site experiments and numerical simulations.

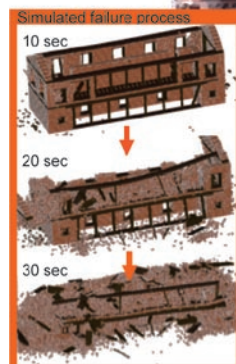


### Dr. Aiko Furukawa

*Associate Professor, Graduate School of Global Environmental Studies*

[www.ges.kyoto-u.ac.jp/cyp/modules/contents/index.php/shokai/faculty\\_staff/jishinsaigai\\_risukuron.html?ml\\_lang=en](http://www.ges.kyoto-u.ac.jp/cyp/modules/contents/index.php/shokai/faculty_staff/jishinsaigai_risukuron.html?ml_lang=en)

### Masonry structures in Kathmandu

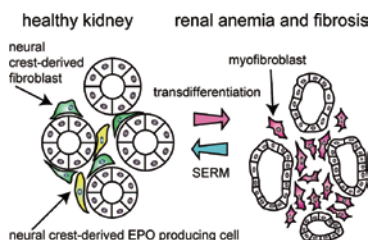


## MED From Incurable to Curable: Renal Anemia and Renal Fibrosis

*Elucidating the molecular mechanisms of renal anemia and renal fibrosis.*

Renal fibrosis and renal anemia are common complications in end stage renal disease, however the molecular mechanisms and reversibility of these complications remain unclear. Erythropoietin is a hormone that stimulates red blood cell production. Prof. Motoko Yanagita employed a genetic lineage tracing method to demonstrate that erythropoietin-producing cells in healthy kidney and scar-producing myofibroblasts during fibrosis originate from neural crest during embryogenesis. She also demonstrated that the dysfunction of the neural crest-derived fibroblasts

is the cause of renal anemia and renal fibrosis, and that these two conditions could be reversed by a selective estrogen receptor modulator (SERM). These findings highlight a potential therapeutic approach for anemia and fibrosis associated with chronic kidney disease. (See also the article of TMK Project in p.16.)



### Dr. Motoko Yanagita

*Professor, Graduate School of Medicine*

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[www.kyoto-u.ac.jp/ja/research/forefront/vol14.htm](http://www.kyoto-u.ac.jp/ja/research/forefront/vol14.htm)



## Gold Medals at iGEM 2010 and iGEM 2012 World Champion in Genetic Engineering



The International Genetically Engineered Machine (iGEM) competition is a worldwide synthetic biology competition for undergraduate students. Using genetic modification technology, each team creates an organism with a new capacity, and competes with other teams.

In 2010, iGEM Kyoto team (representative: Wataru Shihoya) won a gold medal for introducing genes which commit suicide after a certain period of time to *Escherichia coli*, thereby preventing biohazard.

In 2012, the team (representative: Tomohiro Nobeyama) also won a gold medal for modifying *E. coli* genes to make them bloom flowers, regardless of season. It is anticipated that their work will have further success in the future.



### Mr. Tomohiro Nobeyama

*3<sup>rd</sup> Grade Undergraduate Student, Faculty of Science*

[2012.igem.org/Team:Kyoto/Project](http://2012.igem.org/Team:Kyoto/Project) (iGEM 2012 website) [2010.igem.org/Team:Kyoto/Project](http://2010.igem.org/Team:Kyoto/Project) (iGEM 2010 website)



This presentation is available at the following WEB site: [WEB 2012.igem.org/files/video/Kyoto\\_Championship.mp4](http://WEB 2012.igem.org/files/video/Kyoto_Championship.mp4)