RESEARCH FRONTIERS

Cutting-Edge Research in Kyoto University

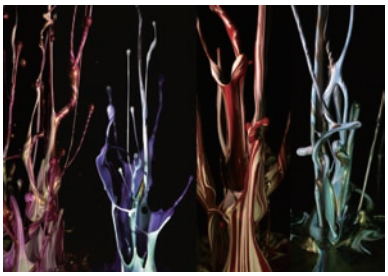
Kyoto University is known for the quality and diversity of its research. Each issue of Research Activities can only highlight a small selection of those endeavors, but we hope to convey an impression of the university's rich academic milieu.

MEDIA-ART

The Sound of Ikebana: Four Seasons

Images of splashing liquids created from sound vibrations.

A projection mapping of Prof. Naoko Tosa's video work was performed on January 17-19 as part of an event to promote the Cool Japan initiative supported by Japan's Ministry of Economy, Trade and Industry (METI) and Ministry of Internal Affairs and Communications (MIC). Prof. Tosa's new video work "The Sound of Ikebana: Four Seasons" was projected on the exterior of the ArtScience Museum at Marina Bay Sands, which is built in the shape of a lotus flower. Singapore Art Week 2014 was held on January 13-19 in Singapore, and several art festivals, including Art Stage Singapore, were held in parallel to bring together galleries and collectors from around the world.



Spring, Summer, Autumn, Winter

Projection mapping "Sound of Ikebana: Four Seasons"

Prof. Tosa's program was presented as part of the festivities, and was supported by METI, the Singapore Tourism Board, the Urban Redevelopment Authority, and other organizations. The Sound of Ikebana is a series of videos shot with a high-speed camera that showcases vibrant images of splashing liquids created from low-frequency sound vibrations. The video installation artistically presents the movement of the splashing liquids as arranged flowers. Through the successive formation of colorful arranged flowers, the video work provided and extraordinary experience of the four seasons of Japan to the viewers in Singapore, a country which doesn't have such distinct seasons.

WEB youtube.com/watch?v=3oO3lohMX7k
youtube.com/watch?v=7kqUpkyctOw

Dr. Naoko Tosa *Professor, Academic Center for Computing and Media Studies*
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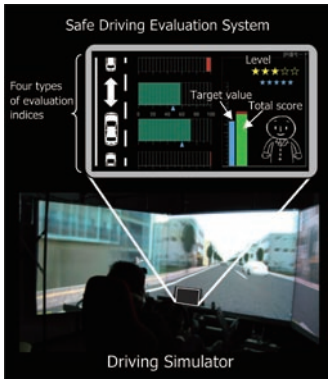
INFO-ENG

Encouraging Spontaneous Safe Driving Behavior

Driver-assistance system with consideration for drivers' behavioral adaptation and motivation.



Driver-assistance systems, such as an emergency brake assist, have become widely used in many passenger vehicles. Meanwhile, a psychological theory known as risk homeostasis theory asserts that drivers' risk compensation behavior will reduce the long-term effectiveness of such systems. Dr. Toshihiro Hiraoka is conducting research on driver-assistance systems that provide drivers with appropriate information and encourage them to change their driving behavior for the better. He has developed an ecological interface for the driver-assistance system based on motivation psychology and gamification, and has performed driving simulator experiments to evaluate the effectiveness of the proposed system.

Dr. Toshihiro Hiraoka
Assistant Professor, Graduate School of Informatics
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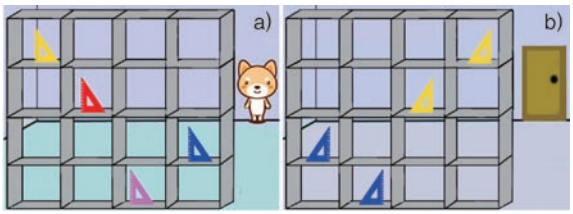
PSYCHOL

The Way People Understand Another People's Mind

Role-play Experience Facilitates Mindreading Skills.

It is often difficult to understand the mind of people who possess different cognitive abilities or traits. One of the effective ways to understand their mind is to have a role play experience. Furumi and Koyasu's (2013, PloS ONE) experimental study has shown that a role-play experience facilitates reading of the mind of people with restricted color vision. In the study, forty students were given a communication task. No-role-play participants made significantly more errors in the restricted color vision condition than in the normal color vision condition, whereas among role-play participants, there was no difference in errors between conditions.



Seen from **participant's** viewpoint Seen from **dog's** viewpoint

Dr. Masuo Koyasu

Professor, Graduate School of Education

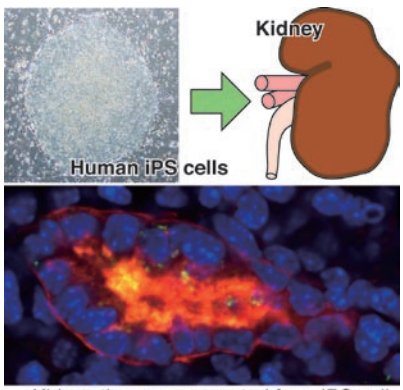
www.educ.kyoto-u.ac.jp/cogpsy/member/koyasu.html

MED-BIOL

Kidney Tissue Regenerated from iPS Cells

iPS cells can serve as a promising source of renal cells and tissues for regenerative medicine.

Kidney diseases cause both medical and economical problems all over the world. Since there are no radical therapies for kidney diseases besides renal transplantation, the development of regenerative medicine strategies using induced pluripotent stem (iPS) cells is required. However, the methods to generate renal cells or tissues from iPS cells have not yet been established. Dr. Kenji Osafune's group recently succeeded in the highly efficient induction of human iPS cells into intermediate mesoderm, an embryonic tissue that gives rise to most cells constituting adult kidneys. It was also demonstrated that human mesoderm cells have the developmental potential to further differentiate into adult renal cell types and form three-dimensional renal tubular structures in vitro. The research group is currently aiming to generate metabolically or physiologically functional renal tissues from human iPS cells to develop regenerative treatments for kidney diseases.



Kidney tissue regenerated from iPS cells
(S. Mae et al., *Nat. Commun.*, 2013)

Dr. Kenji Osafune

Associate professor, Center for iPS Cell Research and Application (CiRA)

www.cira.kyoto-u.ac.jp/j/research/osafune_summary.html

EVOL-BIOL

Web of Life

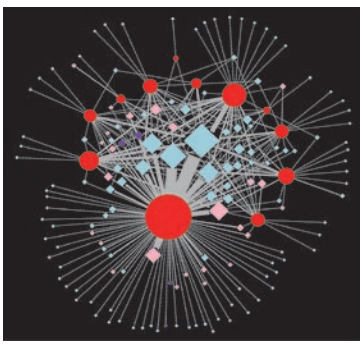
Ecology and genome biology are uncovering the complex networks of species in ecosystems.

Organisms do not live alone. Like individuals in human society, all species in ecosystems interact with other species, forming one of the most complex systems found in nature. By integrating genome biological technologies with theoretical ecology, Prof. Hirokazu Toju and his colleauges are investigating the hyper-complex networks of interactions between plants and their fungal symbionts in roots. As those belowground fungi are essential for the survival and growth of plants in forests, grasslands, and farmlands, their findings provide novel empirical and theoretical bases for ecosystem restoration and next-generation agriculture that fully utilizes the beneficial functions of diverse soil microbes.

Dr. Hirokazu Toju

Assistant Professor, Graduate School of Human and Environmental Studies

sites.google.com/site/toju/



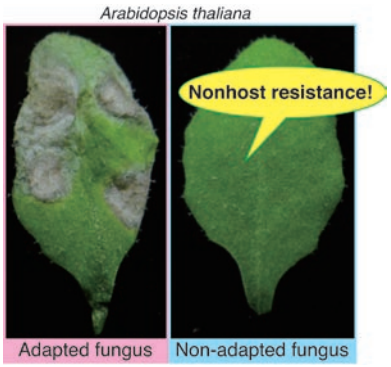
Network representing interactions between plant species (circles) and their root-associated fungal symbionts (diamonds) on Mt. Yoshida, Kyoto, Japan.

PLANT-PATH

Why Are Plants So Healthy around a Lot of Small Enemies?

Molecular dissection of nonhost plant resistance against fungal pathogens.

Fungi are the main plant pathogens and cause approximately 70% of all known plant diseases. However, each fungal pathogen generally exhibits a limited host range, because plants exhibit durable resistance, called nonhost resistance, toward fungal pathogens to which they are not adapted. Dr. Yoshitaka Takano and his colleagues' studies on the nonhost resistance of the model plant Arabidopsis thaliana revealed that this durable resistance is guaranteed by a two-layered defense mechanism. The first layer of defense works to prevent fungal pathogens from entering the plant, and entails the activation of multiple antifungal responses, including antifungal peptide production. The second layer of defense works when the pathogen successfully enters the plant and involves antifungal metabolite synthesis and the subsequent execution of programmed plant cell death around entry sites. This study begins to explain why plants are so healthy in the presence of a lot of potential fungal pathogens.



Dr. Yoshitaka Takano
Associate Professor, Graduate School of Agriculture
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PSYCHOL

Human Memory and Brains

Viewing how memory functions are represented in the human brain.

Memory is one of the important cognitive functions in humans. Traditionally, human memory research has been performed in the field of experimental psychology, but recent advances in functional neuroimaging techniques, such as functional magnetic resonance imaging (fMRI) have enabled scientists to view how memory functions are represented in the human brain. Using the fMRI, Prof. Takashi Tsukiura and his colleagues are trying to disentangle the mysterious link between human memory and the brain. Their interests of research are to study how episodic memories are modulated by other psychological processes, such as emotion, reward, etc., and how memories are affected by aging. They believe that their research could lead to understanding human memory systems from a neuroscientific basis, and could contribute to supporting elderly people with age-dependent cognitive decline.

Dr. Takashi Tsukiura
Associate Professor, Graduate School of Human and Environmental Studies
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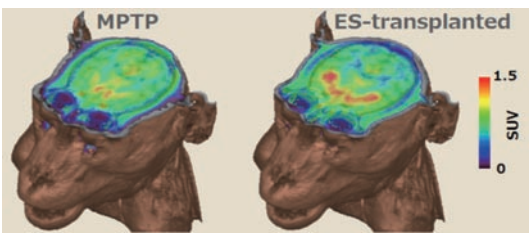
MED-BIOL

Why Don't We Create a New Neural Network?

Transplantation of iPS cell-derived dopaminergic neurons to treat Parkinson's disease.

Parkinson's disease (PD) is a neurodegenerative disease characterized by a progressive loss of midbrain dopaminergic (DA) neurons, which causes motor complication such as tremor, rigidity and dyskinesia. Although pharmacological treatment has proven effective at the initial stage, the fundamental problem of PD is a loss of DA neurons. Dr. Jun Takahashi and his colleagues have been developing a cell transplantation therapy by using iPS cells. They have already succeeded in improving the symptoms in monkey PD models. Dr. Takahashi explains that "the main purpose of surgical treatment is to remove lesions, but we aim to create a new neural network in the brain."



Dr. Jun Takahashi *Professor, Center for iPS Cell Research and Application*
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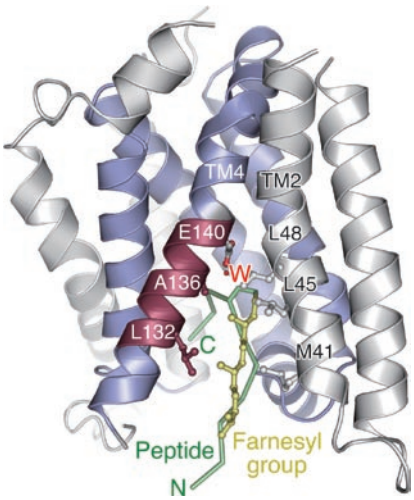
MED-BIOL

First Step to New Cancer Treatment

Structure of new protein linked to cancer revealed.

Some proteins, including Ras, are controlling signals for cell growth and division. Overactivation of the signaling can lead to cancer. Mutations that permanently activate Ras are found in up to 90% in pancreatic cancer. To become active, Ras needs to be processed by a protein called Rce1, which is an intramembrane proteinase. Membrane protein crystallization, essential for structure determination, is still a major challenge. Prof. Iwata and his colleagues applied their unique technique of using an antibody fragment to crystallise Rce1, and succeeded in determining the structure by X-ray crystallography. The structure will provide a boost to the design of new cancer drugs which inhibit Rce1 activity.



Dr. So Iwata *Professor , Graduate School of Medicine*
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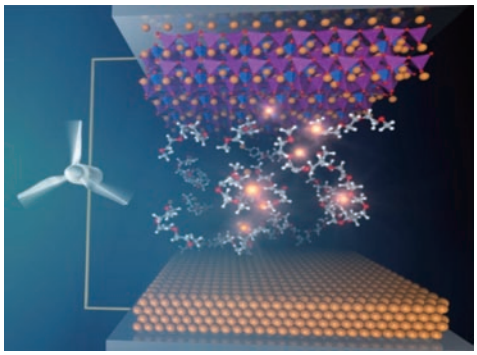
ELECTROCHEM

High-Energy-Density Rechargeable Battery

Magnesium rechargeable battery using earth-abundant and non-toxic elements.



Magnesium rechargeable batteries, in which magnesium ions replace lithium ions as the charge carrier in lithium ion batteries, are expected to be high-energy density. Prof. Yoshiharu Uchimoto and Prof. Yuki Orikasa have developed two distinct approaches to both cathodes and electrolytes for the practical application of magnesium rechargeable batteries. For cathodes, using poly-anion compounds demonstrates a high reversible capacity exceeding 300 mAh g^{-1}. The novel battery system achieves a low cost, practical high-energy-density rechargeable battery free from corrosion and safety problems, and is expected to be a viable alternative to large-scale energy storage devices in smart grid communities and electric vehicles.

Dr. Yoshiharu Uchimoto (left)
Professor, Graduate School of Human and Environmental Studies

Dr. Yuki Orikasa (right)
Assistant Professor, Graduate School of Human and Environmental Studies
www.uchimoto.jinkan.kyoto-u.ac.jp/

EVOL-BIOL

Twisting Evolutionary Puzzle Solved

"Right-handed" snakes drive the evolution of "left-handed" snails.

Right-handed (clockwise coiling) and left-handed (counter-clockwise coiling) snails can rarely mate with each other due to mismatched genitals. For this reason, chirality is generally monomorphic within a species, and is usually right-handed. However, some snail taxa are left-handed. This fact indicates that they have evolved from right-handed ancestors despite the mating disadvantage. Recently, Dr. Masaki Hoso found that some snakes are specialized predators of right-handed snails (the majority), and that the "right-handed" snakes were responsible for the origin of left-handed snail taxa. Dr. Hoso's study illustrates that a single gene for reproductive incompatibility can have a major positive effect on anti-predator adaptation.

Dr. Masaki Hoso
Assistant Professor / The Hakubi Center for Advanced Research
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