Elucidating of the Mechanisms behind Common Complications from Chronic Kidney Diseases

Applicable to chronic kidney diseases drug development

Professor Motoko Yanagita - Graduate School of Medicine
(Hakubi Associate Professor: April 2010 - October 2011)

Chronic kidney disease is a worldwide public health problem. Professor Motoko Yanagita and her research team have elucidated the mechanisms of common complications in the progressive stages of chronic kidney disease; renal fibrosis and renal anemia.

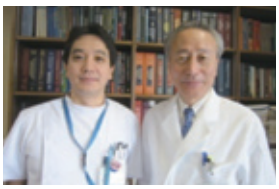
Renal fibrosis is the consequence of an excessive production of extracellular matrix produced by scar-producing cells, whereas renal anemia is mediated by the reduced production of erythropoietin (EPO), an erythrocyte production–stimulating hormone in the injured kidney.

Prof. Yanagita and her team demonstrated that EPO-producing cells in healthy kidneys and scar-producing cells during fibrosis both originate from a single cell lineage with neural characteristics. These cells enter the developing kidney during embryogenesis, and transform from one to the other depending on the status of the kidney. They further demonstrated that renal anemia is caused by the loss of EPO production in this cell lineage during fibrosis, and more importantly, that this loss can be restored in vivo. Discovering of the reversibility of reduced EPO production and fibrosis leads to the possibility of better therapeutic approaches for treating chronic kidney disease in the near future.

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/110913_1.htm

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/

Artificial Hearing without Artificial Power

Piezoelectric materials mimic the function of the cochlear sensory epithelium

Associate Professor Takayuki Nakagawa - Kyoto University Hospital, Graduate School of Medicine
Dr. Takatoshi Inaoka - Kyoto University Hospital, Graduate School of Medicine

We have found that a battery-free cochlear implant can generate auditory responses in deaf animals. Current cochlear implants partially restore hearing in people who have inner ear hair-cell damage with a series of electronic sensors, actuators, and a battery power source. Takayuki Nakagawa and colleagues built a membrane implant, of which size is less than 1 mm, using a material that generates electricity in response to bending, and inserted the device in the cochlea of deafened guinea pigs. Sound was transmitted through the guinea pigs' ear canals to generate vibrations in the membrane, which created electrical pulses that varied with the sound frequency. The membrane's sound tuning was similarly aligned to the tuning in the cochlear basal membrane. In other tests, the implants were artificially stimulated and auditory brain stem activity was recorded. These results suggest that the device could be described as the "technological regeneration of cochlear hair cells," but caution that the device's electrical output must be increased to stimulate primary auditory neurons in the cochlea in the way current implants do. Together, the results suggest that one day, hearing impaired patients may be able to use small prosthetics that mimic natural cochlear function, without the need for a battery.

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/111025_1.htm
www.pnas.org/cgi/doi/10.1073/pnas.1110036108

Imaging Cell-Cell Communications in Living Animals

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

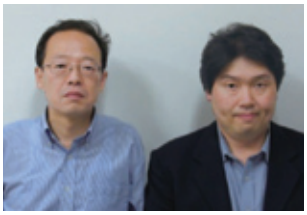
Professor Atsuko Sehara [left] —Institute for Frontier Medical Sciences and Graduate School of Medicine
Assistant Professor Atsuo Iida [right] —Institute for Frontier Medical Sciences

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 professor 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

Heavy Electrons in Flatlands

Unusual superconducting state by the two-dimensional confinement of heavy electrons in artificial superlattices



Professor Yuji Matsuda [Left] - Graduate School of Science
Associate Professor Takasada Shibauchi [Right] - Graduate School of Science

Metals conduct the electron current because they have electrons which are not bounded by atoms, called conduction electrons. At very low temperatures of near absolute zero (-273℃), some metals exhibit superconductivity, a phenomenon of exactly zero electrical resistance. Superconductivity is the most fascinating phenomenon in physics. In metals, electron-electron Coulomb interaction often plays an important role for determining their low temperature physical properties. The ultimately strong electron-electron interaction is attained in the so-called heavy-fermion compounds containing rare earth elements, where the free electron effective mass is enhanced by a few hundred times. Recently we have achieved the first experiment success of putting 'heavy superconducting electrons' in a two-dimensional lattice, which was obtained by fabricating heterostructures unavailable in nature. Superlattices with alternating heavy-fermion CeCoIn5 and nonmagnetic YbCoIn5 layers are grown using the molecular-beam-epitaxy technique. Superconductivity is observed even in superlattices with one-unit-cell thick CeCoIn5 layers, demonstrating heavy-electron superconductivity with purely two-dimensional electron correlations. Most remarkably, the superconductivity in superlattices persists under significantly higher reduced magnetic fields than in the bulk, implying that the "glue" like force holding the superconducting electron pairs together takes on an extremely strong coupled nature as a result of two-dimensionalization -- a situation reminiscent of the high-temperature superconductivity in copper oxides.

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/111011_1.htm

Three Cepheid Variable Stars Discovered in the Center of Our Milky Way Galaxy

The onset of active star formation inferred from infrared observations

Professor Tetsuya Nagata - Graduate School of Science

The region within a few hundred light years of the central black-hole of our Milky Way Galaxy, often called the Nuclear Bulge, presents us with various interesting objects and phenomena. It contains stars with ages ranging from a few million years to over a billion years, yet its star formation history and the triggering process for star formation remain to be resolved.

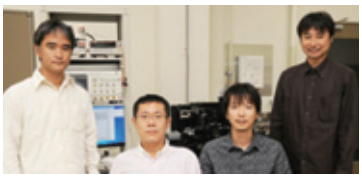
In the Nuclear Bulge, Prof Tetsuya Nagata and his research team discovered three classical Cepheid variable stars. They are pulsating super giants, whose ages can be derived accurately from their pulsation periods. According to the team's infrared observations at the South African Astronomical Observatory, all three Cepheid variable stars have pulsation periods of approximately 20 days and an age of close to 25 million years, suggesting that active star formation occurred at the period around their births. In contrast, the absence of shorter-period Cepheid variable stars shows that the star formation rate was lower between 30 and 70 million years ago. It is suggested that star formation in this region might have occurred on a time scale of a few tens of millions of years.

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/110825_1.htm

Electrical Control of Ferromagnetic Phase Transition in Cobalt at Room Temperature

Development for future low-power magnetic devices

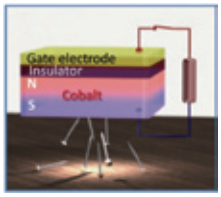
Assistant Professor Daichi Chiba - Institute for Chemical research
Professor Teruo Ono - Institute for Chemical research
Associate Professor Kensuke Kobayashi - Institute for Chemical research
Mr. Kazutoshi Shimamura - D2 student, Institute for Chemical research



From left: Assoc. Prof. Kobayashi, Mr. Shimamura, Assist. Prof. Chiba and Prof. Ono

Electrical control of magnetic properties is crucial for device applications in the field of spintronics. Our research team at the Institute for Chemical research, together with NEC cooperation, have demonstrated the room-temperature electrical control of the ferromagnetic phase transition in cobalt, a representative of the transition-metal ferromagnet family. Solid-state field effect devices, consisting of an ultra-thin cobalt film covered by a dielectric layer and a gate-electrode on top of that, were fabricated (Fig). They found that the ferromagnetic state of the film could be turned on and off isothermally and reversed simply by applying an electric field between the cobalt layer and the gate electrode at room temperature. The shift of the Curie temperature was found to be up to 12 Kelvin by applying an electric field of about ± 2 MV/cm. The result is a significant development for future low-power magnetic devices. For example, it could be used for building a "field-effect magnet"; where the magnet can be easily switched-off to become a non-magnet electrically, and for building a non-dissipative magnetic force generator without an electric current.

In addition, the demonstrated electric field effect of the two dimensional ferromagnet opens up a new way to explore and control magnetism in relation to the dimensionality.



www.nature.com/nmat/journal/v10/n11/abs/nmat3130.html
www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/111003_1.htm

Low-Temperature Oxygen Diffusion in Iron Oxide Thin Films

Keys to developing technologies, such as solid-oxide fuel cells, related to energy and the environment

Professor Yuichi Shimakawa - Institute for Chemical Research

Prof. Yuichi Shimakawa and his research team at the Institute for Chemical Research revealed anisotropic oxygen diffusion behaviors in some iron oxides at low temperatures. When the brownmillerite-structure epitaxial $CaFeO_{2.5}$ thin films were reduced to the infinite-layer structure $CaFeO_2$ by low-temperature reductions with CaH_2, some of the oxygen atoms are released from and others are rearranged within the perovskite-structure framework. By evaluating the changes and the reaction time, the research team found two oxygen diffusion pathways and their related kinetics. The team also successfully prepared $[CaFeO_{2.5}]_m/[SrTiO_3]_n$ brownmillerite/perovskite artificial superlattice thin films and reduced them to $[CaFeO_2]_m/[SrTiO_3]_n$ infinite-layer/perovskite artificial superlattices. In the selective topochemical reduction, the oxygen-ion diffusion in the artificial superlattices was confined within the two-dimensional brownmillerite layers. The results obtained by the research team are expected to be keys to developing technologies related to energy and the environment such as solid-oxide fuel cells.

www.nature.com/nchem/journal/v2/n3/full/nchem.547.html
www.nature.com/srep/2011/110630/srep00027/full/srep00027.html

Why Color Vision Has Evolved in Humans and Higher Primates?

The influence of color on visual snake recognition in human children

Professor Nobuo Masataka - Primate Research Institute

Humans are extremely sensitive to biologically threatening stimuli, such as snakes, and it has been suggested that certain basic properties of the human visual system might have evolved precisely because they facilitated the detection of such fear-relevant stimuli. Nobuo Masataka and colleagues investigated the role of color in the detection of fear-relevant stimuli in human children. They showed 111 children, aged between four and six years old, matrices containing either one snake image and eight flower images, or vice-versa. The images were presented either in color or in grey-scale and participants had to detect the target image as quickly as possible.

As in previous studies on adult humans, all of the children detected target snakes more rapidly than target flowers. However, we found children also responded to both target snakes and target flowers faster when the images were presented in color than in grey-scale. Conversely, while the adults had detected target flowers more quickly in color, their response speed to snake targets did not change whether the images were in color or in grey-scale.

When detecting snakes, human children therefore appear to focus mainly on their color, which contributes towards a faster but less precise response. Adults, on the other hand, use the distinctive shape of snakes to help identify them as a target, regardless of color. The findings are published online in *Scientific Reports* on September 1, 2011.

www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/110901_1.htm

Changing Families and Social Relationships in Southeast Asia

Effects on supporting care

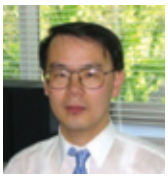
Professor Yoko Hayami - Center for Southeast Asian Studies

Professor Hayami and a team of historians, anthropologists and political scientists from seven Asian countries are working on producing a book on Changing "Families" in Southeast Asia, looking at both the family as an institution through legal, ideological and other national discourse, and at family-based relationships through anthropological fieldwork. In Western Europe, and also to some extent in other industrialized societies, the institutionalization of the modern family took place concomitant with industrialization. In Southeast Asia on the other hand, institutionalization of "the family" took place in varying historical contexts of colonialism, class formation, and emerging nationalist consciousness. Prior to this, rather than enclosed units such as families, networks of intimate relationships constituted the bases of social formation in the region. How then, has this social structure been transformed -if at all- by the institutionalization of the "family"? The family has now long been problematized in the west and other industrialized societies, with demographic changes towards low fertility, aging, and unstable marriages. Some countries in Southeast Asia as well are undergoing the same demographic processes, with further changes involving labor migration and international marriages. How, then, is the "family" and fundamental social relationships changing in Southeast Asia, and how is this affecting social care? These have become crucial questions in present day societies around the globe, and Southeast Asia provides illuminating examples.

www.cseas.kyoto-u.ac.jp/staff/hayami/hayami_en.html

Automatic Speech Recognition Techonolgy

Deployed in the Japanese parliament



Professor Tatsuya Kawahara - Academic Center for Computing and Media Studies

Automatic speech recognition (ASR) technologies have made significant progress in the past decade, leading to services such as voice search and speech translation on smart phones. However, it was still very difficult to accurately transcribe speech in meetings, which are spontaneous and interactive. Prof. Kawahara's group investigated the differences between faithful transcripts of utterances and official meeting records, and formulated a statistical "machine-translation" model of their wording. This has led to an innovative method for semi-automated training of the ASR model using a huge archive of meeting records. In the evaluations conducted with actual Parliamentary meetings, the accuracy of the output defined by the character correctness reached 89%. The system incorporating the technology is now officially used at the House of Representatives in Japan. This is the first system in the world that is officially deployed to automatically transcribe the meeting speech in Parliament. Ongoing developments of the technology include automatic captioning of lectures and assisting hearing-impaired students at universities.

www.ar.media.kyoto-u.ac.jp/diet/index-e.html
www.kyoto-u.ac.jp/en/news_data/h/h1/news6/2011/110512_1.htm

"Cultural Computing"

Art, culture and technology new relationship

Professor Naoko Tosa -Institute for Information Management and Communication

In the present day, one will often be in communication with individuals who have differing cultural backgrounds from their own, so the expectation is higher in understanding the context of other cultures. Because the typical methods in Japan for gaining an understanding of other cultures, are to read books or go to relevant museums, understanding other cultures by finding information is not easy. Can we understand cultures using computers as a medium to supplement thinking and memorization, while it seems to have become more suitable for networking, mobile connections, and two-way communications with its development? This research starts from the topic of art and technology, proceeds to the topic of culture and technology, and finally reaches the topic of a projected world based on the integration of these different concepts where both the creators and viewers of content can reach a deep mutual understanding of each other's culture. This is the field of "cultural computing", that is, the cyber-dealings of the essences of human culture; emotions, national identity and context. It integrates them into verbal and nonverbal information, proposing the prosperity of a field in which computers can better the exchange of cultural information using cultural models. This cultural computing, which is essential for the future development of communication abilities of computers, is a new field that utilizes what humans have accumulated in each culture and its history, in the form of actions or mannerisms when sharing common or peculiar aspects by demonstrating some concrete methodology. Tosa's artworks have been added to the collections of the New York Museum of Modern Art, the National Museum of Art in Osaka, as well as many other museums worldwide.

www.tosa.media.kyoto-u.ac.jp/index.html