

Manipulating Cells with Materials

iCeMS 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), and further down the road spark cellular processes to create chemical materials (cell-inspired materials).

A study of the melded boundary between cells and materials based on a fusion of cell biology, chemistry, and physics is our goal.

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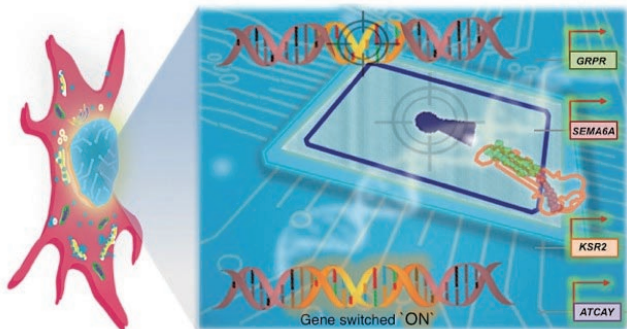
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Research Highlights 2014

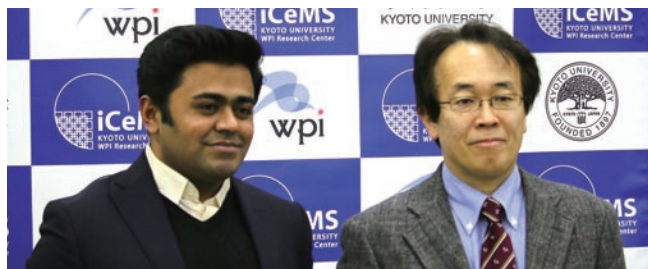
Pressing the Reset Button in Human Cells with DNA-Based Small Molecules

How do you restore order to biological programs in cells that have gone haywire? The answer would be to directly target the source, or in other words, the cell's DNA. This is precisely what a group of researchers led by iCeMS Assistant Professor Namasivayam Ganesh Pandian, from Professor Hiroshi Sugiyama's group, did. They successfully designed a set of DNA-based molecules, which target specific regions of the genome, capable of controlling biological networks. Their study, published in *Nature's Scientific Reports*, may one day help to reprogram cells and treat human diseases, such as cancer and HIV.

"Distinct DNA-based epigenetic switches trigger transcriptional activation of silent genes in human dermal fibroblasts", published on January 24, 2014



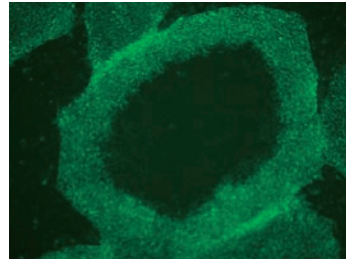
SAHA-PIPs act as keys to unlock gene expression



From left: Assistant Professor Ganesh Pandian Namasivayam, Professor Hiroshi Sugiyama

New Chemical Probe Helps Scientists to Sort Stem Cells

In a joint effort involving 3 iCeMS groups — Motonari Uesugi, Kazumitsu Ueda and Norio Nakatsuji — researchers discovered a chemical probe, called KP-1, that becomes embedded selectively in human embryonic stem (hES) and induced pluripotent stem cells. The study, published in the journal *Cell Reports*, could be used to help scientists and doctors select cultivated cells used for regenerative



Chemical compounds retained in human iPS cells emit a fluorescent green glow

medicine in a manner that is cheaper than existing methods, reversible, and adjustable.

"A Chemical Probe that Labels Human Pluripotent Stem Cells", published on March 7, 2014



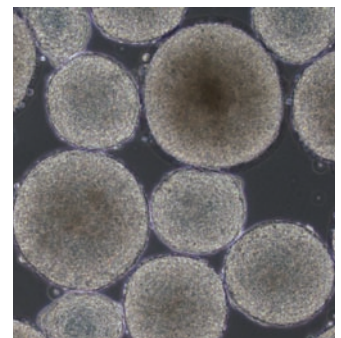
From left: Professor Motonari Uesugi, Professor Kazumitsu Ueda

Polymer Boosts Production of Stem Cells in Three Dimensions

Mass producing human pluripotent stem cells (hPSCs), including embryonic stem cells and induced pluripotent stem cells, for regenerative medicine and drug discovery, may have gotten much easier thanks to a polymer-based 3D culture system developed by iCeMS researchers, led by Professor Norio Nakatsuji. Their findings, published in the journal *Stem Cell*

Reports, could one day be adopted for industrial scale manufacturing of hPSCs to meet the growing demand of large-scale and quality-controlled cells for drug discovery and cell-based therapy for patients.

"A 3D Sphere Culture System Containing Functional Polymers for Large-scale Human Pluripotent Stem Cell Production", published on April 24, 2014



Three-dimensional culture of human iPS Cells using soluble polymers



From left: Dr. Taito Nishino, Senior Lecturer Koichi Hasegawa, Professor Norio Nakatsuji, and Dr. Tomomi Otsuji

Grooving Crystal Surfaces Repel Water

A group of iCeMS researchers, led by Masakazu Higuchi, in Susumu Kitagawa's group developed a novel way to



This image shows a bead of water sitting on top of water resistant porous coordination polymer crystals



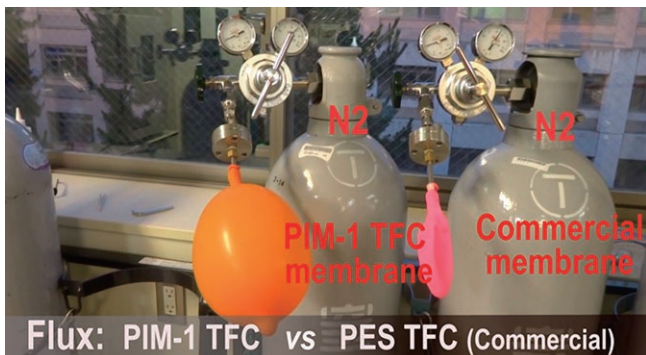
Assistant Professor Masakazu Higuchi

waterproof new functionalized materials by adding exterior surface grooves. Their study, published in the journal *Angewandte Chemie*, provides a blueprint for researchers to build similar materials involved in industrial applications, such as high performance gas separation and energy storage.

"Design of Superhydrophobic Porous Coordination Polymers via Introduction of External Surface Corrugation using an Aromatic Hydrocarbon Building Unit", published on June 27, 2014

To Clean Air and Beyond: Catching Greenhouse Gases with Advanced Membranes

iCeMS Associate Professor Easan Sivaniah led a study to engineer a membrane with advanced features capable of removing harmful greenhouse gases from the



PIM-1 is a highly permeable membrane compared with commercially available ones. The orange balloon on the left illustrates this point as a higher volume of nitrogen gas is able to pass through PIM-1 into the balloon compared with the membrane on the right, connected to the pink balloon

atmosphere. Their findings, published in the British Journal *Nature Communications*, may one day contribute to lower greenhouse gas emissions and cleaner skies.

"Controlled thermal oxidative crosslinking of polymers of intrinsic microporosity towards tunable molecular sieve membranes", published on September 4, 2014

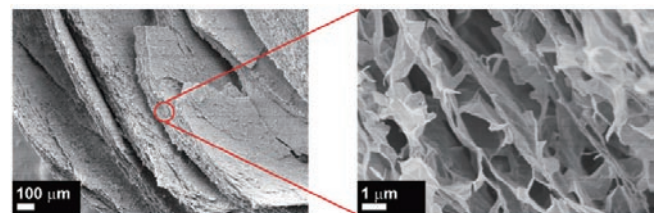


From left: PhD Candidate Kenjo Sakurai, Associate Professor Easan Sivaniah

A Simple and Versatile Way to Build Three-Dimensional Materials of the Future

iCeMS Assistant Professor Franklin Kim's group has developed a novel yet simple technique, called "diffusion driven layer-by-layer assembly," to construct graphene into porous three-dimensional (3D) structures for applications in devices such as batteries and supercapacitors. Their study was recently published in the journal *Nature Communications*.

"Diffusion-driven layer-by-layer assembly of graphene oxide nanosheets into porous three dimensional macrostructures", published on October 16, 2014



These are electron microscopy images of the porous graphene-based structure created by diffusion driven layer-by-layer assembly



From left: Assistant Professor Franklin Kim, Professor Nobuo Uotani

Events in 2014

Light Control in Cell Biology

On June 12-13, iCeMS hosted its sixteenth international symposium on "Light Control in Cell Biology" at Kyoto University.

By combining its strengths in chemistry

and biology to create materials for cell control and cell-inspired materials, iCeMS gathered specialists from around the world to discuss recent advances in the field of "optogenetics" — techniques that utilize light emission to specifically control gene expression in cells.

The symposium, organized by iCeMS

Ryoichiro Kageyama and Shuhei Furukawa, featured 15 international speakers and attracted over 110 participants.

"We hope that this symposium will serve as a launching pad for many exciting discoveries to come in optogenetics, which is a rapidly emerging field," said Kageyama.



Super Science High School Student Fair 2014

iCeMS shared an exhibition booth with the other 8 Japanese WPI institutes (MANA, AIMR, I²CNR, IIS, KAVLI IPMU, ITbM, IFRc, and ELSI) in an effort to reach out to over 4,000 participants at Japan's 2014 Super Science High School Student Fair on August 6-7 at the Pacifico Yokohama Conference Center in

Yokohama. Super Science High Schools (SSH) are secondary schools, approved



by MEXT, which emphasize science, technology and mathematics education.



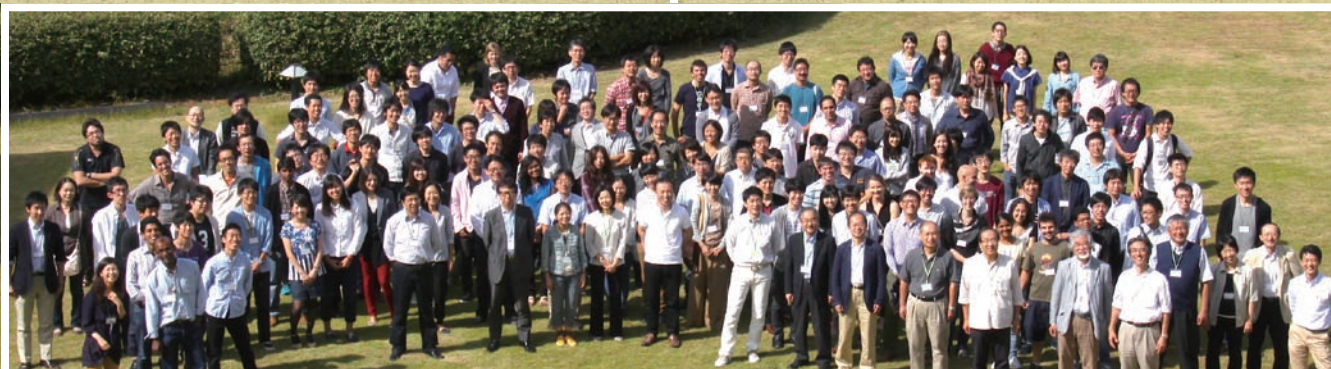
The 6th iCeMS Retreat took place at Miyazu Royal Hotel in Miyazu City on October 3-4, 2014, where approximately 160 iCeMS members participated in the 2-day event filled with stimulating lectures and lively poster sessions.

The first day of the retreat kicked off with Director Susumu Kitagawa highlighting the progress iCeMS has made over the past year and its future research directions, namely to focus on the rejuvenation of adult



stem cells for tissue regeneration and cell-inspired materials for energy storage. For the rest of the day, researchers briefly gave presentations about their areas of study, and engaged in scientific discussions during poster sessions.

The second day of the retreat featured presentations by iCeMS and invited speakers whose talks ranged from reproductive stem cells and drug delivery to robotics.



Awards and Grants

iCeMS Assistant Professor Kaoru Sugimura Wins Early Research in Biophysics Award



Kyoto University iCeMS Assistant Professor Kaoru Sugimura was bestowed the Early Research in Biophysics Award at the 10th Biophysical Society of Japan Symposium in October.

Sugimura was among five individuals given the award for the excellence of her research presentation, titled “Anisotropic tissue stress promotes ordering in hexagonal cell packing.”

The Biophysical Society of Japan has been giving out the award since 2005.

iCeMS Prof Motomu Tanaka Wins Prestigious Franz Von Siebold Prize

In recognition of his contributions to strengthening bilateral ties between Japan and Germany, Kyoto University’s Institute for Integrated Cell-Material Sciences (iCeMS) Professor Motomu Tanaka was selected as the 2014 recipient of Germany’s prestigious Philipp Franz von Siebold prize.

The President of the Federal Republic of Germany has presented the award since 1979, making this the 36th time the prize was awarded. Historically, the Siebold prize has been bestowed upon a Japanese scholar for enhancing intercultural understanding and academic exchanges between both countries.

Tanaka — who specializes in biological physics, interface science, and non-



equilibrium soft matter — has spent 15 of his academic years in Germany, where he originally started off as a postdoctoral fellow in Technical University Munich and later became a professor at the University of Heidelberg in 2005 after brief stints at Stanford University and Kyoto University. Currently, Tanaka has faculty positions at both the University of Heidelberg and Kyoto University’s iCeMS.

Over the years, Tanaka has been an active organizer of international symposia and leveraged his ability to bridge both countries in order to promote opportunities for German and Japanese researchers to meet and interact face to face. He is also involved in the HeKKSaGON alliance — a consortium between universities in Heidelberg, Kyoto, Karlsruhe, Sendai, Göttingen, and Osaka.

“While Germany has tended to collaborate with China and India in the past, we’ve observed a recent shift in the landscape to Japan, who is seen as both a rival and valuable partner. This trend is also evident across Europe,” said Tanaka. “It is my hope to conduct dynamic research with young scientists, through cultural exchanges, in order to transcend the boundaries that exist between research fields. I am highly honored to receive this award.”

The awards ceremony took place at the annual Humboldt Foundation meeting on June 3rd in Bellvue Palace, which is situated in Berlin and is the residence of the German President. Tanaka is the sixth Kyoto University researcher to receive the Siebold prize.

Susumu Kitagawa Selected as 2014 Thomson Reuters Highly Cited Researcher

Thomson Reuters has selected iCeMS Director Susumu Kitagawa as one of its 2014 Highly Cited Researchers for ranking in the top 1% most cited papers in the field of chemistry.

This distinction was determined after examining the top 1% cited papers published in Thomson Reuters Web of Science Core Collection — a database of over 12,000 journals from around the world — during an 11-year period spanning from 2002 to 2012. Only journals meeting Thomson Reuters’ strict criteria are counted, and researchers from 21 general fields were chosen on a percentile-based selection that allows for

younger researchers to also make the cut.

In total, 3,215 individuals were selected as 2014 Thomson Reuters Highly Cited Researchers. The first list to come out was in 2001, in which more than 7,000 researchers were included.

Kitagawa was previously awarded as a Thomson Reuters Citation Laureate in 2010.

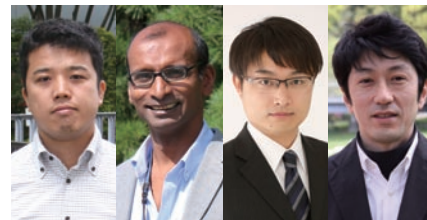


Four iCeMS Researchers Selected for Large-Scale JST Funding Grants

The Japan Science and Technology Agency (JST) has awarded iCeMS Ryotaro Matsuda, Easan Sivaniah, Hideki Hirori, and Motonari Uesugi with large-scale PRESTO and CREST grants. Their proposed projects are expected to drive technological innovations in high priority research areas that will make major social and economical impacts in Japan.

PRESTO — Precursory Research for Embryonic Science and Technology — typically funds individual researchers for up to 3 years with a budget of 40 million JP yen, while CREST — Core Research for Evolutional Science and Technology — funds team-oriented projects for five years with a total budget up to 600 million JP yen.

Out of 788 CREST and 1,569 PRESTO applications submitted from all over Japan, only 65 (8%) and 105 (7%), respectively, were accepted in the end. Kyoto University was awarded 10 CREST grants, out of which one belonged to iCeMS Deputy Director Uesugi. Similarly, Kyoto University was also awarded 10 PRESTO grants, of which 3 belonged to iCeMS Associate Professors Matsuda, Sivaniah, and Hirori.



edX Students and Japan Minister Visit iCeMS

Kyoto University Invites Top Performing edX Students to Japan

Kyoto University rewarded the top six performing students enrolled in its online course, titled "The Chemistry of Life," with all-expense-paid visits to Japan.

The edX course was the first massive open online course (MOOC) offered by Kyoto University, and provided students with a toolbox for generating ideas to solve scientific problems from an integrated chemistry and biology approach.

Out of over 17,000 students enrolled in the class, 6 were chosen based on the quality of peer reviewed homework assignments, and a brief 2-minute YouTube video in which they succinctly explained the logic behind their research project proposals.

Kyoto University's iCeMS Professor Motonari Uesugi, who taught the course, said, "It was difficult narrowing down the candidates for this reward because we received many excellent ideas from edX students, but the enthusiasm and originality of the 6 we ultimately selected really stood out."

During their 6-day visit, the students were given a tour of Kyoto University, including iCeMS, where Uesugi is a Professor and Deputy Director. They also had an opportunity to meet with Kyoto University President Hiroshi Matsumoto after a half an hour press conference with Japanese media, which was featured in several national and local newspapers.

The students traveled from around the globe — Peru, Latvia, Phillipines, USA, Serbia, and Vietnam — to visit Kyoto University, for a trip that made a strong impression them, as best stated by Graham Wimbrow, "Kyoto University iCeMS has changed my life!"

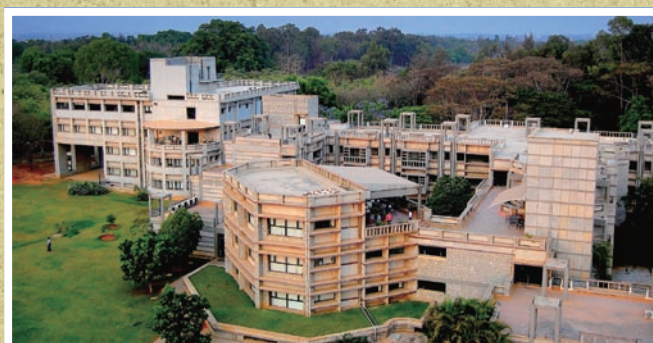


MEXT Minister Shimomura Visits iCeMS Satellite Lab in India

On August 7, 2014, Japan's MEXT Minister Hakubun Shimomura paid a visit to iCeMS

NCBS-inStem satellite facility in Bangalore, India. One of the objectives of his trip was to promote further scientific collaboration between India and Japan. Therefore, iCeMS NCBS-inStem satellite facility was selected as a prime example of close ties between research institutes in both countries. NCBS Deputy Director Upinder Bhalla, iCeMS

Senior Lecturer Kouichi Hasegawa and other members provided explanations about the facilities and collaborative research to the delegate, which was followed by a lively discussion on how to nurture further research collaborations going forward. Shimomura was given a tour around the facility to get a better understanding of laboratories in India.



Young Researchers at iCeMS

iCeMS Welcomes Short Researcher Stays

Martine Haan, a young researcher at Heidelberg University, recently completed a successful 3-month internship at iCeMS. She joined iCeMS Fellow Ohtan Wang's laboratory, and quickly made an impact on Wang's group.

Wang commented, "Martine was able to come in, have a positive influence on my students, and accomplish a lot in the laboratory in the relatively short period of time she was here. She may have also discovered a new mechanism which will help us understand how neurons regulate their genetic information in space and time."

While Haan worked hard in the laboratory, she was still able to make time for sightseeing and meeting Japanese students.

When asked about any troubles she experienced while living in Japan, she commented, "For me, everything was smooth because iCeMS Overseas Researchers Support Office helped me with all of the necessary paperwork and

took care of me during my stay."

Wang is hoping that more students come to iCeMS for short internships, which will benefit both Japanese and overseas researchers, alike.



iCeMS Science 101 Meeting Brings Together Young Researchers

iCeMS Science 101 is an informal bi-monthly meeting organized by postdocs from several iCeMS groups to learn about the diverse areas of research being conducted at the institute.

The meetings were first launched in October 2013, and have been held seven times to date, generally taking place in the evening in the second floor exhibition

hall of iCeMS Main Building.

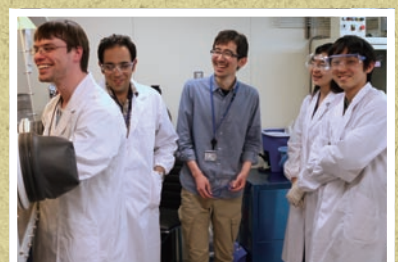
"We all come from different scientific backgrounds," explained Christian Wolpert, who is a co-organizer of the meeting, "and because of this, it sometimes feels like we are speaking different languages."

"The hope of these gatherings is to provide a foundation for young researchers to communicate with one another in order to further promote interdisciplinary studies," said Silvia Pujals, another co-organizer.

Participation is open to all who are interested in attending, including students.



Young Researchers at iCeMS



iCeMS Recruitment

Attention Graduate Students and Postdocs, Kyoto University's iCeMS Wants You!

iCeMS is an international research center situated in Japan's most historical city, Kyoto, which served as the nation's capitol over a 1000 years ago, and is home to thousands of shrines and temples. Experience life in a dynamic and cutting edge research environment while immersing yourself in Japan's exquisite culture.

At iCeMS, we aim to fuse the fields of chemistry and cell biology in order to create tools for use in regenerative medicine and energy storage. With 11,000 square meters of open laboratory and office space, state of the art equipment, world renowned scientists, and friendly English speaking staff at your disposal, iCeMS offers a rich environment for enabling leading edge science.

Typical benefits for iCeMS postdocs include:

- Average salary around 300,000 JPY/month (3,000 USD)
- Contract length is flexible (e.g. 3 months to 2 years)
- Support for visa paperwork and getting settled into your new life in Japan
- Social Insurance

Interested applicants are encouraged to look on iCeMS homepage for research groups with open positions, or contact groups of interest directly.



Overseas Researchers Support Office

ORSO

When overseas researchers come to Japan, they are faced with a number of challenges that can sometimes be frustrating and prevent them from starting out their new lives. For instance, the process of setting up a bank account or signing a contract for a mobile phone may be difficult for non-Japanese speakers. ORSO's objective is to help overseas researchers with these kinds of situations so they can stand on their own two feet and enjoy their experience in Kyoto. In fact, our assistance starts even before they arrive in Japan by completing necessary documents related to visas and searching for suitable housing. Once here, we are available to support and provide advice on matters related to living in Japan. ORSO also arranges seasonal tours for researchers and their families.



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The WPI program was founded in 2007 at the initiative of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) with the aim of establishing and operating a network of world-class scientific research centers.



Kyoto University's iCeMS is one of nine institutes in this program.
For details see www.jsps.go.jp/english/e-toplevel/