Institute for Integrated Cell-Material Sciences

iCeMS

Our World, Your Future

Kyoto University

Vol. 4
2017 March

An image of a macrophage captured by a Scanning Electron Microscope (SEM). A macrophage eats and digests microbes and invaders in the human body. It also eats dying cells in the body as they exhibit an "eat me" signal to macrophages. Turn to page 6 to read the full story.

contents

Feature

Researchers in iCeMS

Many researchers are working at iCeMS every day to create new technologies that make our lives more comfortable and solve life's mysteries. We asked 15 of these researchers not only about their research, but also about what they do to relax or have fun. Let's find out what kind of scientists, and people, they are.

Questions

Research Field and Theme

- Why did you become a researcher?
- What is your hobby?/ When do you feel relaxed?
- What is your favorite experiment, theory, device, lab equipment?

Creating any nanoscale network structure ad arbitrium

Organic and metal ions provide a wide variety of networks that contain nanospaces. By using these materials, we can easily and safely store useful gases and other chemical resources at high densities. They have great potential in applications for our immediate environment, as well as in a wide variety of fields, such as the global environment, resource use, outer space, life, and energy. Therefore, these porous materials are extremely valuable both scientifically and industrially.

Detective fiction novels
I like reading them, because I can be a detective in the fictional world.

Kabuki and Super kabuki
I think the representation of human nature is fantastic.

Susumu Kitagawa
Director

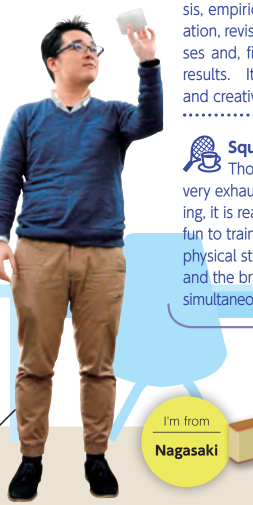
I'm from Kyoto

Chemistry of Molecular Assemblies is like the sociology of molecules

As a group of people from different disciplines that often shows high creativity, we try to form assemblages of heterogeneous molecules to implement new functions. We try to understand the principles of the molecular assembly process and transform that knowledge into new fabrication protocols for novel materials. In particular, our research interest lies in coordination chemistry and focuses on materials at the mesoscale with applications in cell biology and electronics.

I love the process of research - hypothesis, empirical trials, evaluation, revision of hypotheses and, finally, reporting results. It requires logic and creativity.

Squash
Though very exhausting, it is really fun to train both physical strength and the brain simultaneously.



Shuhei Furukawa
Associate Professor

I'm from Nagasaki

Exploring and decoding the cell's secret codes

My research goal is to create "Smart Genetic Switches" that precisely turn ON and OFF genetic and epigenetic factor(s) of therapeutic importance. Harnessing high-throughput technologies, we decipher the unexplored key information of the desired cell-type-specific genes and artificially control them to achieve targeted reprogramming and differentiation. Advancing our synthetic strategy to construct tailor-made DNA-based epigenetic switches could open new vistas of clinical opportunities to treat diseases like diabetes, autism and cancer.

I was amazed to see how a genetic material could be orchestrated to re-generate dinosaurs in the movie "Jurassic Park" and felt inspired to pursue a career in research.

Chess is an art. Even with restricted moves, this game offers infinite possibilities and lets my imagination soar. Also, it promotes my decision-making skills.

Ganesh Pandian Namasivayam
Assistant Professor

I'm from Tamil Nadu, India

Visualizing what's going on inside cells and observing their responses in real-time

Our bodies use various kinds of signals to keep us healthy. These signals are produced to start or stop certain cell responses. If these signals do not work well, this might cause disease. My research focuses on developing tools to visualize the signals working inside the cells and precisely understand their functions. In this way, we can approach bona fide cell behavior, compared to the information obtained by classical methods that involved destroying many cells.

I loved experiments ever since I was in kindergarten. Collecting iron pieces by magnets and mixing colored water fascinated me. Science class was my favorite in elementary and middle school, and I ended up becoming a scientist.

Ura-senke style
I've studied Japanese tea ceremony for about 20 years.

Reiko Sakaguchi
Program-Specific Assistant Professor

I'm from Saitama

Can we make a "miniaturized human"?

I'm an engineer working on developing a device to handle "tiny" things such as cells. My research goal is to recreate a human body within a single device, named the "Body on a Chip". This will enable rebuilding the physiological and pathological conditions of the human body in vitro, a powerful tool for studying fundamental biological systems.

Solenoid valve
I use it for controlling a microfluidic device. The sound the valves make when opening and closing reminds me that indeed I am "engineering".

Scuba diving
It opened me up to a new world. It is also fun to meet creatures that we cannot see on land.

Ken-ichiro Kamei
Program-Specific Research Center Associate Professor

I'm from Higashi-muramaya, Tokyo

Controlling the dynamic motion of molecules and ions in solids

We design and synthesize solid materials for energy and the environment. New glass ion conductors are specifically our target for next-generation batteries and human-interactive devices. Our synthesized materials are usually just a "powder", but they possess the dynamic motion of molecules and ions at the nanometer scale. We hope to contribute towards improving human life by using dynamic solid materials in the future.

Glove box
I like the glove box because it enables the synthesis of new materials under an inert atmosphere.

I like the liberal atmosphere in California, and I collect items related to the state, such as furniture and cutlery.

Satoshi Horike
Associate Professor

I'm from Osaka

Finding the truth by unbiased screening approaches based on molecular biology, biochemistry, and genetics

We focus on transmembrane proteins. Plasma membranes of cells function not only as a barrier between other cells, but also as a scaffold for communication, such as recognition of dead cells and cell fusion, and to perform chemical reactions, such as blood coagulation. Mutations in cell membrane-regulating proteins cause a variety of human diseases. As basic research, we try to deeply understand how biological phenomenon related to plasma membranes is regulated and how human diseases occur to consider cures for diseases.

Screening
I like to perform a screening because I feel I can learn from nature.

I play a bass guitar. I especially like Funk, Acid JAZZ, and R&B, which have a good combination of a bass guitar and drums.

Jun Suzuki
Professor

I'm from Amagasaki, Hyogo

Combining physics, statistics, and biology to elucidate the principles of design for living forms

How do cells push and pull each other to trigger precise deformations of a tissue when shaping the body? The answer is essential for understanding the development of animal forms. By combining mechanical and genetic perturbations, along with live imaging and Bayesian force-inference, we address the physical principles underlying regulation of epithelial morphogenesis.

Kaoru Sugimura
Program-Specific Research Center Associate Professor

I wanted to find a new way of describing the world. I thought I had a better chance of becoming a scientist than a poet or a film producer, plus I really enjoyed doing science experiments in middle school.

Sharpening forces
They calm my mind.

I'm from **Tokyo**

Unraveling the workings of the brain, which is the most beautiful organ created through evolution

The brain has an elaborate network of ten billion neurons that control all our conscious and unconscious behaviors. We seek to understand the mechanism of how the brain is constructed by studying the dynamic movement of developing neurons. Our brain is the most complex and the most beautiful organ created through evolution. It is the forest that houses the soul of what makes a human. A journey to unravel its workings is nothing but delightful by any measure.

Mineko Kengaku **Professor**

Watching movies and reading novels
From the point of view of brain science, Memento (movie) and The Housekeeper and the Professor (book) are very interesting. Both are stories based on main characters with anterograde amnesia. It has made me contemplate happiness (a reward for the brain).

Live-cell imaging.
The movement of a living cell is surprisingly dynamic.

I'm from **Tokyo**

We are researching at **the University of California, Los Angeles (UCLA)**

Fuyuhiko Tamanoi
Program-Specific Professor

I'm from **Sendai, Miyagi**

Testing new therapies of cancer by making use of nanoparticles

Cancer research encompasses basic scientific studies to translational approaches. One of our aims is to develop various nanoparticles (their diameter is 40 to 200 nm diameter) for delivering anti-cancer drugs to tumor. Exciting new therapies are recently being developed that will likely change the way cancer treatment is carried out.

Animal model systems are important in investigating mechanisms of tumor formation and in devising ways to inhibit tumor growth. Two types of animal models are used. One is the chicken egg tumor model that is established by transplanting human cancer cells into the membrane surrounding a chicken embryo in a fertilized egg. The other is a mouse xenograft model.

Basketball
This is a thrilling game that is decided in the last few seconds.

Dan Ohtan Wang
Program-Specific Research Center Associate Professor

I'm from **Shenyang, China**

Seeing actions in the brain with color

When we learn, the neural network in the brain undergoes structural changes. One such change has been revealed to be the formation of new synapses, or junctions between neurons, during learning. We are working to develop a system for observing the living brain of an organism and monitoring the movements of molecules that are involved in synapse formation during learning in real time.

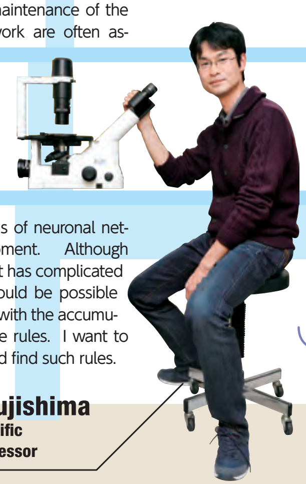
Imaging (Experiment), **stochastic gene expression** (theory), **microscope** (device), **glass flask** (equipment)
I like to paint memories with my favorite colors.

How do neuronal networks form in the developing brain?

Defects in the formation and maintenance of the neuronal network are often associated with neurological diseases. By utilizing various imaging technologies, I try to clarify the molecular mechanisms of neuronal network development. Although neuronal circuit has complicated patterns, it should be possible to construct it with the accumulation of simple rules. I want to understand and find such rules.

I have liked small creatures, such as insects and killifish, since I was a boy. I watched a TV program and learned that small molecules function within the cell like delicate machines. Since then, I started being interested in molecular biology.

Mystery novels
I think that solving mysteries is a common aspect of detective stories and research.



Kazuto Fujishima
Program-Specific Assistant Professor

I'm from **Osaka**

Researching the first stage of the body formation process

I'm researching the origin of the body and how our bodies form. I think the research will help to understand our bodies and cure disease.

Koichi Hasegawa
Program-Specific Research Center Junior Associate Professor

I was attracted by various forms and the ecology of life by watching David Attenborough's "Life on Earth" (BBC). I just wanted to know how that diversity was formed.

Motorcycle touring and playing a bass guitar
Both have rhythms and heavy bass sounds, which make me feel good without any particular reason.

I'm from **Tamana, Kumamoto**

Taking a complicated molecular process and expressing it with a simple mathematical model

With technology manufacturers pushing for smaller and smaller devices, there is a demand to control the shapes of materials on the nanoscale. By developing new mathematical models and simulation techniques, I identify strategies to assemble molecules into tiny wires and other useful objects.

Daniel Packwood
Junior Associate Professor

Running,marathon
Running is important to me because my research involves sitting down for long periods of time. It's important to have a balanced life. While running, I got to accidentally know my favorite spot, Kumogahata, which is a small village about 30 km north of Kyoto station.

I'm from **Christchurch, New Zealand**

Investigating, with laser technology, a state of materials that changes on atomic scale and at ultrafast speed

With the progress of ultra-short pulse laser technology, it has become possible to investigate chemical reactions occurring in an extremely short period of time (less than 1 trillion second!) and to control the properties of materials. In my research, I aim to develop new laser and measurement technologies and to discover novel states and functions of materials unknown to date.

Hideki Hirori
Program-Specific Research Center Associate Professor

I became strongly attracted to research-ing ultrafast phenomena using a femtosecond pulse laser when I was an undergraduate student.

In any experiment, when my efforts bear fruit and find unpredictable new experimental results, I get enough pleasure to raise my fists, even when alone.

Yes!

I'm from **Yamaguchi**

=Research Field and Theme =Why did you become a researcher? =What is your hobby?/When do you feel relaxed? =What is your favorite experiment, theory, device, lab equipment?

Human cells number around 37.2 trillion. Of these, around 10 billion expire every day. As they die, they signal "eat me", a message sensed by white blood cells known as macrophages. If macrophages fail to eat the dying cells, dead cells will rupture, causing autoimmune diseases. Mysteries, including how signals are presented and sensed, still surround this important process. Professor Suzuki and his group are moving forward with their elucidation.

Jun Suzuki
Born in 1977 in Amagasaki Hyogo. Went to University of Victoria in New Zealand for research in 1999. Received a PhD in 2007 from Osaka University's Graduate School of Medicine. Held the position of Research Fellow with Department of Medical Chemistry, Kyoto University Graduate School of Medicine from 2007 to 2015. Remained in his present position since 2017, after working for the Immunology Frontier Research Center at Osaka University.

Observing cell function to research the truth

Jun Suzuki Professor

"My research investigates on biological phenomenon at the cellular level to find mechanisms. I was so happy when I found out how cell functions were regulated..." Suzuki talked cheerfully, looking like a child finding a new game.

Indecisive college days

"As a student, I wasn't enthusiastic about anything". Suzuki seemed embarrassed when he thought back. "In my high school days, I formed my own band, and at the same time I prepared for examinations, but I couldn't concentrate on either." At the university, Suzuki was not a diligent student. But then, two turning points occurred.

The first was studying with Professor Sumiko Gamo, a genetic researcher. Suzuki was lucky to receive one-on-one lessons. "The class was excellent. She covered a wide range of topics, such as the history of science and the origins of genetics." He gradually gained interest in life sciences. One day he told Gamo that he would like to study abroad, and she pointed him to an exchange program. He immediately wrote a proposal and was accepted to travel to New Zealand.

Enthusiastically seeking "something interesting"

His research theme while in New Zealand was the relationship between alcoholism and genes. He learned that people's ability to drink relates to the variation of alcohol-metabolizing enzymes. From this, his desire to learn not only the connection between a gene and a disease, but also the biological phenomenon, grew.

Suzuki developed a "learning attitude" from students around in New Zealand. "Many students took out loans, and if they failed a class, they had to pay for the same class again. Laziness means a matter of life." Interacting with such enthusiastic students, he found the fun of research. This was the second turning point for Suzuki.

An image of macrophages eating Apoptotic-cells. Apoptotic cells are labelled with dyes and manipulated to fluoresce only when eaten.

As an aspiring researcher after his experience in New Zealand, what he valued was "whether I find it interesting or not. After returning to Japan, I decided to follow researchers who use interesting methods. Professor Shigekazu Nagata of Osaka university, has already produced many achievements about cell death. In his methods, he first observes a phenomenon and then examines a related gene." Suzuki found this research method in line with his way of thinking. Following Nagata's method, he asked himself what topic would be interesting. He decided to investigate the "eat me" signal, found many years ago but with no mechanisms elucidated.

Suzuki worked for ten years under Nagata. He gradually began to consider launching new projects in a new place. "The boy raised by his parent wishes to leave home and stand on his own feet. My feeling was something like this." At just the right moment, Suzuki formed a connection with iCeMS and came to Kyoto.

Rethinking the importance of research

Suzuki always found himself in the laboratory conducting experiments, except when he had to leave for business trips. "I don't stick to my idea. If there is a truth under the experimental data, we may encounter unexpected findings. We can also uncover truth when we conduct an experiment many times. While I'm very happy when I can conduct research as expected, I think correcting the gap between my idea and experimental data is also interesting. If possible, I want to always conduct experiments." As moving into leadership, Suzuki felt a little sad to move away from experiments.

On the other hand, he finds it worthwhile to work as a leader. "Students and postdocs conduct experiments, and their enthusiasm is essential. Last-moment efforts can lead to the important findings. No matter if the experiment is successfull or not researchers can persist if they have experiences to bring them enthusiasm. I also have some precious experiences when I didn't give up. My job is to create the environment where students can make their final pushes."

Ask the ancients for new truth

Suzuki expresses his research as "Onkochishin: we ask the ancients about modern affairs." The "eat me" signal of dead cells to macrophages was found about 25 years ago, but people didn't have the experimental techniques to investigate further. "Cancer and iPS cells tend to become topics of conversation in society. However, if you shift your point of view, you will notice a lot of interesting biological phenomenon that remained unsolved." The same signal was also found in the blood clotting process, and it is expected that understanding these will help find causes of genetic diseases, such as muscular dystrophy and spinocerebellar degeneration. "With advanced experimental techniques, you can find unexpected connections between biological phenomenon and diseases that have not been investigated enough. "It would be so interesting if our own research is considered as cutting-edge science many years from now."

While Suzuki (shown on the right) was studying abroad, he enjoyed playing bass guitar at an open mic café in Wellington.

The products around us, such as clothes, memo paper, and liquid crystal displays are made from materials. Generally, materials are divided into inorganic substances, such as metals and ceramics, and organic substances, such as plastic and fibers. Organic materials are generally light and easy to process, but don't have durability and are deformed by heat. On the other hand, inorganic materials have durability and heat resistance; however, they are heavy and fragile. Associate Professor Satoshi Horike develops new materials, which mix the positive qualities of both organic and inorganic materials, an effort that will revolutionize energy and the devices around us.

Satoshi Horike
Born in 1978 in Osaka. Received a PhD from Kyoto University Graduate School of Engineering, with a major in Synthetic Chemistry and a Biological Chemistry Doctor of Engineering. Held a position as Postdoctoral Fellow with the Department of Chemistry at the University of California, Berkeley and as an Assistant Professor of the Department of Synthetic Chemistry and Biological Chemistry, Graduate School of Engineering, Kyoto University. Has held his present position since 2017.

Opening up the future of materials science

Satoshi Horike Associate Professor

"This coaster is made from ceramics." Horike picked up a coaster bought in California. "Ceramics are made by burning inorganic materials, creating a hard material that can withstand heat greater than 1,000 degrees. If we add organic materials to ceramics, we can combine the high-performance of ceramics with lower temperature thresholds for deformation. If the material is softer, it may also be easier to form. I synthesize various materials together to produce new, innovative materials."

A hungry spirit in America

In childhood, Horike moved about ten times because of his father's job, changing places to Chicago, Bahrain, and other places. He spent high school in Tokyo and went to the Faculty of Engineering at Kyoto University. "Every few years, I moved to another place, so Kyoto was the first place I could settle down. I lived here for 6 years until I graduated."

After Horike completed his master's degree program and worked in the electronics industry for a year, he went back to Kyoto University and obtained Ph.D. Then Horike decided to go to California. "Generally, industry research results are not individual. I wanted to publish my research paper under my name, so I decided to work in the university."

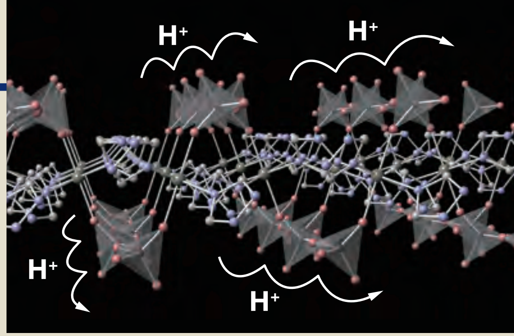
At the University of California, the hungry spirit of researchers from distant countries inspired him. "No matter how excellent, it was difficult for a researcher to continue leading-edge efforts in their home country because high-quality research environments do not yet exist in some of the Middle Eastern and African counties. While always thinking about their home country, they had the strong will to achieve results in America. I was so inspired by this, while valuing the high-standard of research in Japan." Their nationalities, languages and early environments were different, but Horike shared the same research goals as his fellow workers, and he treasured his relationships with people from all over the world. "When we conduct chemistry and materials science research, we must be persistent, understand the importance of teamwork, and enjoy the unexpected. Experiences with my international colleagues pushed me to consider my strength and weakness objectively, allowing me to develop my own personal research style."

Horike in front of the Department of Chemistry during his time at the University of California.

The future of materials science depends on students' inspiration

After Horike returned to Japan, he became Assistant Professor at the Graduate School of Engineering, Kyoto University, conducting research into new battery and glass materials. "Until you try, you don't know what will happen when you synthesize materials. Our motto is 'enjoy the unexpected'. I let students experiment freely as long as possible and value their inspiration."

This style was influenced by Professor Susumu Kitagawa (current iCeMS Director). When Horike enrolled in his master's program, Kitagawa stood in front of a solid-state NMR that cost tens of millions of yen and told him, "You can use this equipment however you like. Think of something interesting you can do with it." This was all Kitagawa said. "At that time, I felt happy to be free and enjoyed conducting experiments. Now I know it is not an easy thing to say." Students' unconventional thinking in the field of science sometimes leads to a chance discovery. "I should not deny their inspiration as seemingly useless, but instead, make use of it. Operating a team of students and young researchers in the field of materials science, I want to raise them up to excellent leaders."



An image of a solid material that can transport proton ions without water. This material can contribute to making smaller-sized and lower-cost fuel cell vehicles.

Conducting research without complacency at iCeMS

In January 2017, Horike opened his own lab at iCeMS and started leading new research efforts at iCeMS. The average age of iCeMS leaders, at 44 years old, is young. "There are many researchers similar in age, all doing admirable research. I would like to continue in the lively iCeMS environment, influenced by my peers and questioning myself."

Materials science can make life more comfortable. In any field, the balance between fundamental and applied research is important. "I pursue research to produce new materials and ideas. It's no problem if I don't know how to use a material when I produce it. I hope we produce a result useful for industry researchers, and in this process, I feel satisfied that my research connects with real society".

iCeMS Fund — Help us grow

At iCeMS, we develop new insights into the principles of life that distinguish living things from non-living things, and harness these ideas to create bio-inspired super materials and devices that will revolutionize health-care, medicine, industry and the Environment to create a sustainable world for us all.

Whilst much of the work we do here is Pure Science, we are absolutely certain that our research combining high-level chemistry, cell biology and physics, at the border between materials and life, will meaningfully impact the world in which we live.

The research we carry out at iCeMS will help doctors to fight such perennial problems as heart disease, cancer, and degenerative brain conditions, as well as develop invaluable new medicines and therapies. Our revolutionary work also addresses key issues such as global warming, pollution, over-dependency on fossil fuels, and the availability of clean drinking water.

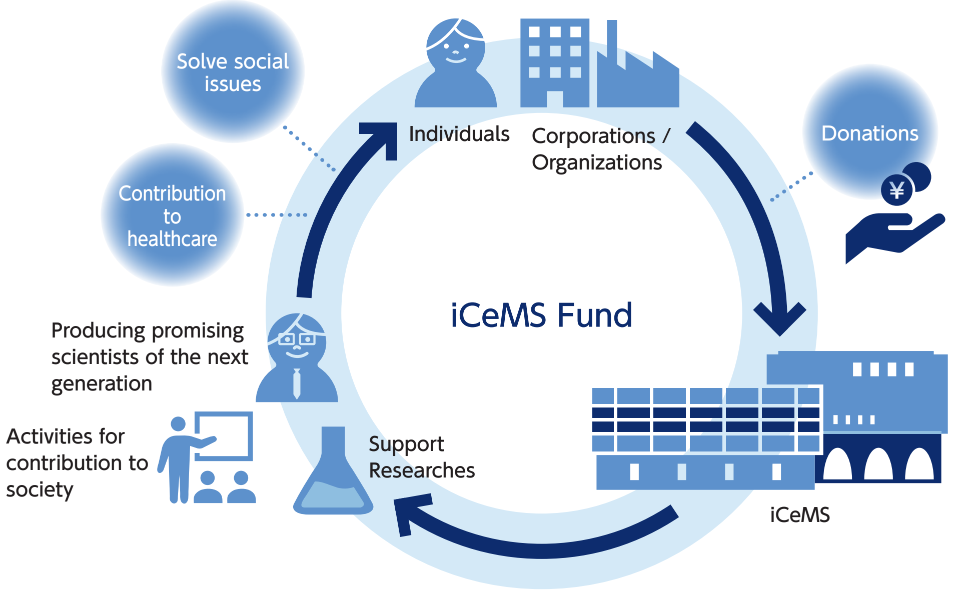
Generous gifts from donors like you provide the financial and moral support needed to continue and develop this research at the cutting edge of modern science. We are not merely content to improve existing technologies, but seek to affect paradigm shifts in the way science may benefit humanity.

Help us to help the world. Together we can make a difference because we care.

Donors

iCeMS would like to sincerely thank all those who have given their support.

Hiroshi Tanaka
Hiroyasu Tabe
Junko Kobayashi
Kenichiro Murai
Kenji Takano
Koichi Shirose
Kyoto Gakuen High School
Takako Yano
Takashi Tokunaga
Tomoko Kato
Yoshinori Takeuchi
Yoshiyuki Tsuda



Kyoto University Fund webpage

http://www.kikin.kyoto-u.ac.jp/contribution/icems/

iCeMS in brief

Research Highlights

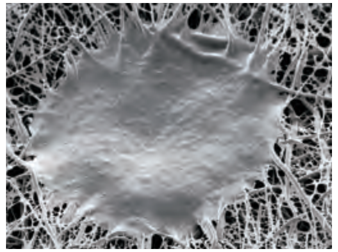
Vitamin D discovery could prove key to new treatments

iCeMS Deputy Director Motonari Uesugi and his team have identified a new way vitamin D helps control the balance of lipids in the body. This key finding could advance development of new treatments for metabolic disorders and certain cancers.

©Tatjana Baibakova / 123rf

A nanofiber matrix for healing

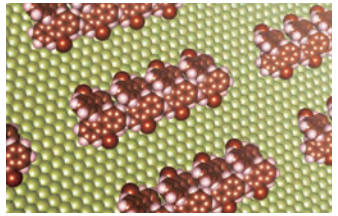
A matrix made of gelatin nanofibers on a synthetic polymer microfiber mesh may provide a better way to culture large quantities of healthy human stem cells. Developed by a team of researchers led by Drs. Ken-ichiro Kamei, Li Liu and Yong Chen of iCeMS, the 'fiber-on-fiber' (FF) matrix improves on currently available stem cell culturing techniques.



Human stem cells that grew on the 'fiber-on-fiber' culturing system

Learning how to fine-tune nanofabrication

Dr. Daniel Packwood is improving methods for constructing tiny "nanomaterials" using a "bottom-up" approach called "molecular self-assembly". In the future, this method may be used to produce tiny wires with diameters 1/100,000th that of a piece of hair, or tiny electrical circuits that can fit on the tip of a needle.



Formation of chain-shaped structures on a copper surface via molecular self-assembly

What's new?

iCeMS led Japan Delegation at World Stem Cell Summit in Florida

For the fifth year running, iCeMS co-organized the 2016 World Stem Cell Summit, held in West Palm Beach, Florida on December 6-9. The event attracted policy makers, academics, industry leaders and patient advocates from over 40 countries. At the iCeMS' led symposium, the Japanese panel highlighted recent key scientific findings as well as new products and technologies.

iCeMS hosts Kyoto University International Symposia in Thailand

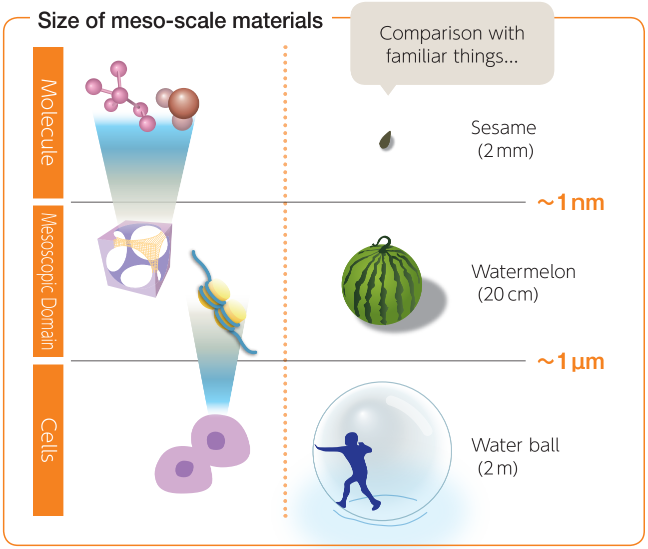
On February 2nd and 4th, iCeMS hosted the Kyoto University International Symposia in Thailand. The symposium on the 2nd was held at the Vidyasirimedhi Institute of Science and Technology. Researchers from both countries gave presentations under the theme of "Materials for a Sustainable Future". On the 4th, they changed the venue to Bangkok and held another symposium co-organized with the Kyoto Union Club. After plenary talks and presentations, the reception party for the day took place, enlivening the event.

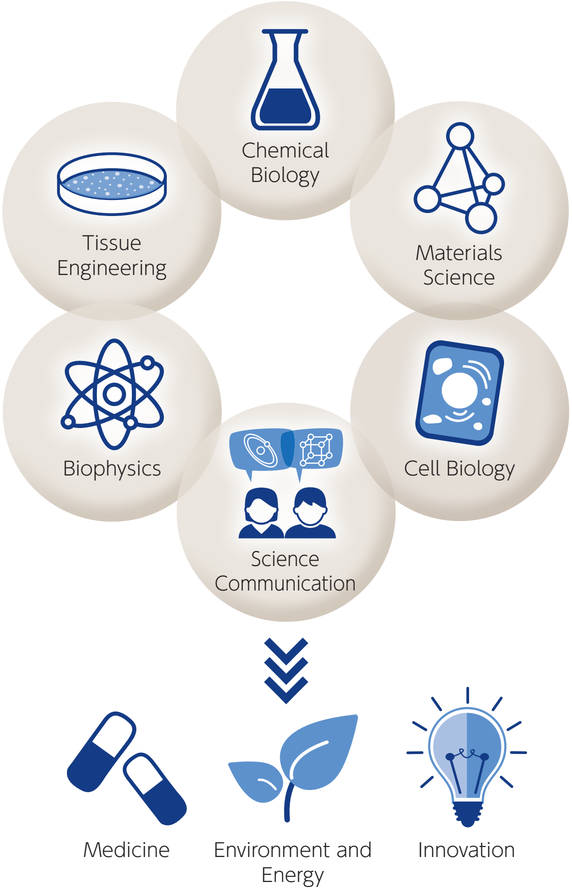
Explore the secrets of life and innovate for the good of society

iCeMS' Mission

- Explore the secrets of life by creating compounds to control cells
- Create life-inspired new materials for the future

Global warming. Pollution. Disease. Aging. These major concerns can no longer be countered by traditional single discipline-based research. At iCeMS, cell biologists, biophysicists, chemists, material scientists, physicists, and bioengineers share ideas and work together to devise new ways to integrate cells and materials, all for the greater good. We find inspiration through collaboration. We leverage our critical mass of scientific and technological knowledge into purposeful, transformative innovations for the practical benefit of society.





iCeMS
Our World, Your Future
Vol.4
2017 March

Production Institute for Integrated Cell-Material Sciences at Kyoto University
Yoshida Ushinomiya-cho, Sakyo-ku, Kyoto 606-8501, Japan
Phone: +81-(0)75-753-9755 | Fax: +81-(0)75-753-9759
E-mail: info@icems.kyoto-u.ac.jp
Homepage: http://www.icems.kyoto-u.ac.jp
Production/cooperation: Kyoto Tsushinsha Press, Design: Takayoshi Nakasone