Institute for Integrated Cell-Material Sciences

# iCeMS
# Our World, Your Future

Kyoto University

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contents



Worker bees and queen bees, despite being born alike as larvae, look structurally different when grown. What causes this difference? There is a tiny factor behind this phenomenon. Turn to page 2 to read the full story.

***Since June 2015 iCeMS Learning Lounge has brought the work of young scientists to the public. In the forum, open to any curious listener and not only those with scientific background, researchers present why, in 20 minutes or less, their research is important for the world. By connecting their research to society at large, they make an easily understandable case as to why it will change the future. In this newsletter, we present Dr. Namasivayam, whose talk was held in the second session.***

# Nature-inspired cure for the incurable.


## Ganesh Pandian Namasivayam

Assistant Professor


We often see on the daily news that a recent scientific discovery has brought us one step closer to the cure for diseases considered incurable. But how close are we? Dr. Namasivayam brings us a closer look at the need to develop nature-inspired therapeutic strategies to speed up the journey towards sustainable cures for complex diseases.

I would like to ask you a simple question before moving on to my topic. Can you identify which is the queen bee and which is the worker bee in Fig.1? The queen bee is on the right, looking large and healthy.

**Fig.1** Photos of a worker bee (left) and queen bee (right) that, despite being born alike as larvae, look structurally different when grown. The science behind this difference also has a profound effect on human health.

They started life as babies, in the same form of insect larva, but as they grow up, they look different. What made this big difference? There is a tiny factor. The factor behind this phenomenon is important not only for the structural development of bees, but also for human health and wellbeing.

## "The guardian of the genome" p53

The key word here is cure. Looking at the Merriam-Webster dictionary, cure is derived from "cura", a Latin word which means a divine god that protects humans from evil effects. So, "Incurable" literally means a disease which cannot be resolved.

There are many incurable diseases in the world, and as if that's not enough, we keep inventing new ones. Even though two well-known major diseases causing human death, cancer and diabetes, have been known since the B.C. era, we can still only offer just a superficial treatment instead of overpowering the disease out of the system.

When we face a problem, we need to get to the root of the problem. We have traveled a long way since the B.C. era and now know fundamental information, specifically the genome, which is presented in Fig. 2.

We are made from combinations of three-billion letters (ATGC). These letters stand for adenine (A), thymine (T), guanine (G), and cytosine (C). The 7.3 billion people living in the world today all have an almost same combination of these letters, arranged in a double helical structure, known as DNA. A gene is a functional unit of DNA. DNA is called the blueprint of life, as it stores the biological information necessary for life and informs the biological system when needed through a code called the genetic code. There are about 20,000 genes in a human.

With modern technologies, we have discovered sensitive genes in which a fault or defect can cause disease. We can also identify other genes that can resolve problems, which we call "guard genes" or "caretaker genes." Let me introduce the most important caretaker, the "guardian of the genome", known as p53.

**Fig.2** A representative illustration of the human genome, comprised of the three billion letters required to create a human being.


**Fig.3** The structure of DNA. Two strands coil together to form a double helix through chemical crosslinks of letters that make up the language of DNA: Adenine (A), Thymine (T), Guanine (G), and Cytosine (C).

Imagine the cute little smiley face in Fig. 4 as a cell in our body. When a disease signal comes in the form of a mutation or a change in DNA, p53 starts the machinery, like the wheels in Fig. 4, to either repair or arrest the mutation. If there is no hope, p53 destroys the damaged cells to rejuvenate new cells. When p53 is either absent, modified, or arrested by another gene like the cancer gene E6, cells go out of control and cause cancer. In fact, p53 is known to be affected in 50% of cancer cases.

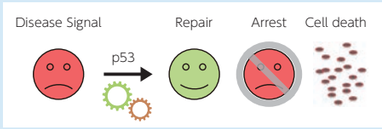



**Fig.4** The role of the natural guard p53. To stabilize the disturbed cell (emoticons) by disease signals, p53 starts biological machinery (wheels) to either repair, arrest, or destroy the affected cells, thus avoiding the uncontrolled cell division causing cancer.

## Bacterial immune system used to restore p53

One of strategies developed to restore p53 is a type of targeted gene-editing, called CRISPR/CAS9. This latest technology was inspired by a tiny living organism, bacteria. Microorganisms, like bacteriophage viruses look for the opportunity to infect DNA by injecting their DNA into bacteria. The bacteria, however, protect themselves by a specific immune system, called CRISPR, which can recognize foreign DNA elements. CRISPR carries the DNA repair enzyme, CAS9, which prevents virus infection by targeting and cutting out the foreign DNA. Scientists have been using this technology to develop many CRISPR-CAS9 systems for editing the gene(s) of interest. One of the CRISPR systems, E6 CAS9, was developed by researchers from North Carolina University to cut only the oncogene E6 in the human genome and restore the natural guard p53.

This technology is not only useful for cancer gene editing but also for HIV, muscular dystrophy, and many other diseases. However, some problems remain with this approach. This technology involves gene modification, and few of us want to have our own DNA cut, even if we have a disease. To avoid this concern, there is an alternative approach that can control the governors outside DNA. This phenomenon is termed epigenetics.

Epigenetics is the process of the methylation or acetylation of DNA or histone proteins without changing DNA sequences. The information from the modification is passed on, like the inheritance of DNA, to daughter cells.

## A system to control gene expression

The epigenome is a kind of functional layer that lies above the genome and controls which genes need to be switched off or silenced and which genes need to be switched on or expressed. What is the state of "silenced" or "expressed" genes? Human DNA is 20 meters long and bound around

**NAMASIVAYAM Ganesh Pandian**, born in Tirunelveli, completed his schooling at SBOA Matriculation School, Chennai, Tamil Nadu, India. Ganesh received his Master's degree from University of Madras, India, specializing in biotechnology. In 2002, he began multidisciplinary research involving microbial biotechnology, biosensors, and biotransformation with Prof. Anju Chadha, (Department of Biotechnology) and in the Electrical Engineering Department, Indian Institute of Technology – Madras (IIT-M), India. In 2006, Ganesh received a scholarship from the Ministry of Education, Culture, Sports, Science & Technology in Japan to conduct doctoral research on "A novel innate immune system in insects" with Prof. Hidetaka Hori at Niigata University. Ganesh continued as a Research Assistant Professor in the Hori Lab and as a Scientific Advisor in the Ushiki patent office, Niigata, until 2009. Since 2010, he has been working at the Institute for Integrated Cell-Material Sciences (WPI-iCeMS), Kyoto University, with Prof. Hiroshi Sugiyama. Ganesh is now a Program Specific Assistant Professor working on the creation of nature-inspired smart biomaterials for therapeutic applications.

the histone protein like a spool, as shown in Fig. 5. The position and way in which DNA is packaged determines the ON or OFF status of the gene.

This state depends on the presence or absence of marks over the DNA, epigenetic marks that are either expression marks or silence marks. When silence marks are present, illustrated by the red buttons in Fig. 5, they send signals to histone proteins to tightly pack the DNA, thereby protecting or hiding the genes away. As our body also cannot read what is written on this hidden sequence of DNA, these genes are OFF.

On the other hand, when expression marks appear, as shown in green, they send signals to the histone proteins to relax and loosen up, revealing the hidden DNA. When this happens, the genes are switched ON. Gene expression is simply the act of DNA being read by the body system to inform compound molecules that have several biological functions, such as proteins. Cells maintain their function and state by correctly controlling gene expression.

## The switch to make a queen a queen

I hope you still remember the first question that I asked regarding the queen bee. At some point in development, one set of bee larvae is fed with only worker jelly, which go on to become worker bees. The other set is fed royal jelly that go on to become queen bees. Royal jelly that contains fatty acids silences the silencing marks, which in-turn activates the expression marks and initiates the queen factors in the genetic code.

We humans also experience a similar phenomenon. Extrinsic stimuli such as smoking, drinking, and poor diet can affect our health and leave bad epigenetic marks, not only on us, but also on our children and even grandchildren. For those of us who have already corrupted our genetic system and are afraid of being blamed by our children and grandchildren, there is good news. These epigenetic marks are reversible.

Among several approaches, the most preferred way by both clinicians and patients is to use small molecular switches as drugs. Imagine the genome inside the diseased cell, where key genes like the guard gene p53 are silent. When taking these small molecules, they enter genome and switch on the guard genes to recover their function.

## How to aim at specific switches

Although this technology restores the natural guard genes, selectivity is an issue. Some genes that are not supposed to be disturbed can also be activated with this molecule. Finding a way to direct molecular switches to specific DNA sequences is a key point in the field of drug designing.

Regarding this specificity, I will briefly introduce a small molecule called pyrrole imidazole polyamides, or PIPs. This was discovered by Professor Peter Dervan of the California Institute of Technology from the naturally occurring antibiotic, distamycin derived from a bacteria and the amino acid, histidine.

Pyrrole is shown as the blue circle and imidazole as the yellow circle in Fig. 6a. Like the genetic code, there is a binding rule proposed for these small molecules. Their arrangement in different places allows for reading of different sequences of ATGC. For example, pyrrole-pyrrole can read either A or T, while imidazole-pyrrole can read GC. A significant advantage of PIP is its ability to enter live cells and bind to pre-designed DNA sequences, in a fashion similar to natural body factors.

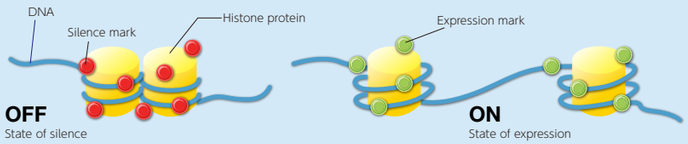



**Fig.5** In the OFF state, when DNA (blue) is bound tightly, OFF marks (●) cause histones (yellow) to huddle close together making the gene invisible [left], but when loosened by ON marks (●), the gene is visible to be expressed [right].

## Genetic switch discovered by Sugiyama group

In nature, gene expression is controlled well at both the genetic and epigenetic level. In Professor Hiroshi Sugiyama's lab at iCeMS, we combine this selective DNA binder, PIP, with a synthetic epigenetic switch called SAHA to make a nature-inspired genetic switch known as SAHA-PIP.

We made 32 kinds of SAHA-PIPs by positioning the blue dot pyrrole and yellow dot imidazole in different places, where they bind to different DNA letters. When we tested their activity in human skin cells, we found that when one kind of SAHA-PIP was employed, a key gene important for stem cells, OCT4, was activated. When another SAHA-PIP was employed, the gene PIWI, whose absence can cause infertility, was expressed. Another SAHA-PIP activated PAX6, which is important for retina development in the eye.

Each SAHA-PIP activates a different set of key genes, and the gene networks activated by one SAHA-PIP do not activate the others. They are much more selective than the simple small molecule switches explained before. Some of our SAHA-PIP epigenetic switches also activated key guard genes like the HIV-1 silencing gene, MX2, autism silencing gene, CNTNAP2 and the anti-obesity gene, KSR2.

At this moment, we are using nature-inspired genetic switches only as a research tool. To progress towards our ultimate aim of making this strategy available for clinical use, we need to make these switches more tunable and carefully consider their design, as the epigenome is more complex than the simple marks discussed here. However, I am confident that at some point these small molecules can be fine-tuned for clinical applications.

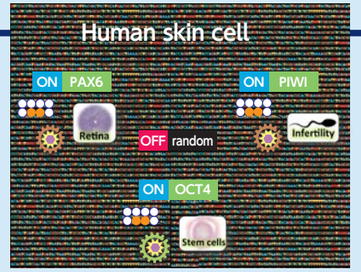



**Fig.7** Distinctive SAHA-PIPs successfully lighted ON the exclusive set of therapeutically important genes associated with i) infertility, ii) retinal cells and iii) stem cells in human skin cells, where they are usually silent or OFF.

*

To conclude, we took a major step in the journey towards finding a cure for several diseases with the discovery of the DNA helical structure in 1953. Within the next 50 years, we made several important discoveries, including the landmark completion of human genome project. In the last decade, we have accelerated our journey at such a rapid pace that discoveries have become daily news. I am confident that with the nature-inspired strategies like CRISPR-CAS9 and by finding innovative ways to restore the natural genetic guard, a cure will be achieved soon. I, personally, believe in the famous saying that nothing, I mean nothing cures like nature.

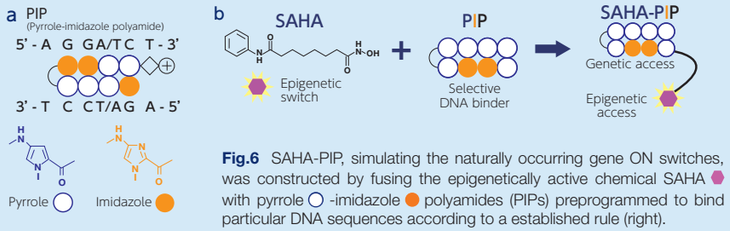



**Fig.6** SAHA-PIP, simulating the naturally occurring gene ON switches, was constructed by fusing the epigenetically active chemical SAHA ⬟ with pyrrole ○ -imidazole ● polyamides (PIPs) preprogrammed to bind particular DNA sequences according to a established rule (right).

## Why don't you experience the energetic atmosphere in the Learning Lounge?

iCeMS is growing as a visible institute that commands attention from the world. To continue to develop, the success of young researchers is essential. At the Learning Lounge, we activate interdisciplinary research in chemistry, cell biology and physics to improve our international presence and convey cutting-edge information. We have broadcast these presentations for free through the address below.

**http://www.icems.kyoto-u.ac.jp/e/rsch/ll/**

This Learning Lounge, which is held once every two months, is open to anyone who is curious about scientific research. There is no need to contact us in advance. Please check the webpage of iCeMS to look for future Learning Lounge Seminars.

**#1 June 29, 2015**
**Talk 1** Dr. Ken-ichiro Kamei (iCeMS Young Chen Lab) **My Life as a Microchip** *
**Talk 2** Dr. Koh Nagata (iCeMS Kazumitsu Ueda Lab) **What Did You Eat Yesterday? – How to Manage Your Cholesterol** *

**#2 August 3, 2015**
**Talk 1** Dr. Ganesh Pandian Namasivayam (iCeMS Hiroshi Sugiyama Lab) **Nature-inspired Cure for the Incurable —Coming soon?** *
**Talk 2** Dr. Marcel Hörning (iCeMS Motomu Tanaka Lab) **What Is a Heart Attack?** *

**#3 October 21, 2015**
**Talk 1** Dr. Aya Sato-Carlton (iCeMS Peter Carlton Lab) **How Is Your DNA Passed on to Your Children?**
**Talk 2** Dr. Hideki Hirori (iCeMS Koichiro Tanaka Lab) **Making Invisible Worlds Visible**

**#4 November 19, 2015**
**Talk 1** Dr.Yuta Takano (iCeMS Hiroshi Imahori Lab) **Powering the People with Nano Solar Cells**
**Talk 2** Dr. Yoji Kojima (iCeMS Mitinori Saitou Lab) **Decoding the Keys of Our Life Cycle**

* Talks with asterisks are available on the internet.

After the presentation, we had the opportunity to exchange opinions and ideas among researchers and the audience.

## Feature article 2 Creating new ways of learning

***This academic year four younger iCeMS professors instructed Kyoto University's small-class education course (pocket seminar) for freshman students, a series taught since 1998 by instructors from outside the student's faculty to broaden their perspectives and develop deeper insights into humanity, society, and nature. The curriculum titled "Looking beyond Chemistry and Biology" took a practical learning approach, based on the iCeMS model of innovation, to cultivate an awareness of what it takes to become the great scientists of tomorrow.***

Students meet for first time in a few months after the end of the course

# The Upside of Chaos

## Learning 'the iCeMS Way'


**Interviewees** (Professors)

**Shuhei Furukawa** (Assoc. Prof.)
**Kaoru Sugimura** (Asst. Prof.)
**Masakazu Higuchi** (Asst. Prof.)
**Kazuto Fujishima** (Asst. Prof.)

**Interviewer** (Science Communication Group)

**Ayami Joh** (Research Associate)


**Ayami Joh** ● What was most important to you in preparing the course?

**Kaoru Sugimura** ● Shuhei and I proposed the idea of incorporating both the chemistry and biology points of view. Through the perspectives of various disciplines, we wanted students to understand that at a university, there are no easy answers. They must start by asking the questions themselves.

Dr. Kaoru Sugimura

**Shuhei Furukawa** ● We wanted to incorporate the "iCeMS style", where people from different disciplines work together, and we decided to examine one theme from two perspectives, chemistry and biology. I initially suggested a debate style, where groups would argue which one is "better", chemistry or biology, so they could justify each field with their own words. But Masakazu and Kazuto suggested that we raise a scientific question instead.

Dr. Masakazu Higuchi

Dr. Kazuto Fujishima

**Masakazu Higuchi** ● It's easy to create a dichotomy, but I was more curious to see what existed beyond that. So the theme was "looking beyond perspectives."

**KS** ● We got creative with the course format too. Following the general format of a scientific paper, we had the students set up a query themselves, discuss the relevant background, come up with the experimental methodology, and present it in class. When writing a scientific paper, you normally start by identifying where you currently stand in the pool of knowledge built by your predecessors, and then you throw in your two cents. We explained that a paper is structured in the exact same way.

**AJ** ● If there had been a similar course taught when I was a freshman, I would have taken it. Even now, I still struggle to speak up in discussions and presentations.

**MH** ● The course goes against learning styles that students are accustomed to in primary education. To not search for the correct answer is baffling to them. But in reality, having an open mind is the key to creative thinking.

**KS** ● Based on this approach, we did our best to make the course description as attractive as possible.

**AJ** ● You were looking for students who wanted to "experience cutting-edge research with no queries, answers, or disciplinary borders"?

**Kazuto Fujishima** ● We added another criterion: those who "hated to be taught."

**MH** ● We wanted people who could relate with these words.

Dr. Shuhei Furukawa

**KF** ● We worried that there wouldn't be enough applicants because the bar was set too high. But it actually became a good filter!

**SF** ● Sixteen students enrolled. By luck, there were an even numbers of students from multiple majors. We included many phrases related to different themes taught during the course; hence, it caught the eye of students across fields.

**KS** ● The first lesson for the pocket seminar was that "we want this seminar to become a reference for [you] to decide what you want to study, not a seminar for the sake of learning."

**SF** ● The students kept up with the professors, so we kept raising the bar. Some students said preparing for class was hard work, but when the course was over, we realized that not a single student missed a day of class!

### A flexible mind is a creative mind

**AJ** ● Students rarely get the opportunity to discuss science with undergrads in different majors. It's not quite the same as belonging to the same tennis club.

**KF** ● Quoting a student: "interdisciplinary fusion will become important in the future." I was utterly impressed.

**SF** ● But first, to fuse disciplines, you must be a specialist of some kind. You can't 'specialize' in interdisciplinary fusion from the get-go.

**KS** ● It's important to steer away from

Dr. Ayami Joh

### At-a-glance

- **Title**
  When Chemistry Meets Biology
- **Course Schedule**
  [Course Schedule]
  ①Introduction (Self introduction/ What is biology?/What is chemistry?) ②DNA ③Energy production ④Light ⑤General format for writing a scientific paper/Presentation contest prep. ⑥iCeMS lab tour/Presentation contest prep. ⑦Presentation contest ⑧⑨The five senses ⑩⑪Evolution ⑫Presentation contest prep ⑬presentation contest
- **Class Structure**
  [Lecture] Professors explain the basic facts and latest research findings on a given theme from both the viewpoints of both chemistry and biology
  [Discussion] Students and professors discuss a topic to find new perspectives beyond the fields
  [Presentation] Students make a question, and present a new scientific idea related to that theme
- **Aims**
  To cultivate a student's a) creative thinking unconstrained by fields of research, b) ability to construct a logical scientific argument c) ability to express oneself, and d) ability to complete a team assignment in a team.
- **Professors**
  (field of research / favorite pastime)
  Shuhei Furukawa (inorganic chemistry/squash, beer), Kaoru Sugimura (biological physics/soccer, architecture), Masakazu Higuchi (coordination chemistry/fishing, wedding speeches), and Kazuto Fujishima (Neuroscience/reading).

these beliefs: "I'm a biologist, so math is unnecessary"; or "I am a physicist, so biology is not relevant to me."

**AJ** • I thought students understood that point very well. I spoke to four of them before this round-table talk. They seemed to have enjoyed communicating with those from different faculties during the course. One said that "chemistry alone was enough before, but taking the course made them also want to be in a biology lab."

**MH** • When I first came to iCeMS, I felt that chemistry and biology were totally different. For example, I am a chemist, so a "molecule" brings to mind a small benzene ring with a substituent attached. But biologists imagine protein.

**KS** • Too true!

**MH** • I asked, "...so then, how would you describe an amino acid?" And the response I got was, "well, an amino acid is an amino acid..."

**SF** • Even though an amino acid is a molecule too…

**MH** • You use the same word with different meanings, so the conversation doesn't flow. This becomes one of the reasons why disciplinary boundaries exist. But we didn't hide this conflict of opinions amongst ourselves. We agreed to disagree.

**SF** • I enjoyed the 90 minute-long faculty meetings that took place after the classes.

## Student Voices

**Erika Sugimoto** (Fac Agr) **/ Kohtaro Takahashi** (Fac Sci)
**Kazumasa Nakanishi** (Fac Med) **/ Ryo Mizunuma** (Fac Pharm Sci)

**•Why did you choose this course?**

**T:** Other courses have one professor for every five or six students, but this course had one professor for four students. I have liked debates since high school, so I looked forward to speaking with the professors. But the syllabus could be a bit over the top and intimidating to some.

**S:** I've always liked chemistry, but not biology. I thought that if I took a chemical approach to biology, I might like it. I also wanted to practice debates and presentations.

**M:** To be honest, this seminar was my 4th choice. I applied for another seminar about fungi and Buddha statues, but there were too many applicants. This course was what was left in the additional registration. I immediately applied after seeing the course title. I only found out later that it was a discussion-based class.

**N:** It wasn't my first choice, but I was inspired by the course description and syllabus. I also wanted to hone my presentation skills early on.

**•What did you think of the teaching style?**

**N:** I felt comfortable from the first day of class because the professors were so frank with us. In a normal lecture, it's easy to become passive, but the discussion-style learning was enjoyable to me. It was refreshing to hear the science and engineering majors' way of looking at things.

**T:** While many courses only teach facts and not how they can be applied, this course did not allow for passiveness. I enjoyed using a different train of thought, but I always felt tired after class.

**M:** I felt that greater importance was placed on intelligence rather than simple accumulation of knowledge, i.e., how to output acquired knowledge. I am very satisfied to have participated in an active course.

**S:** Each person had a large role and responsibility because the presentations were done in small groups. I couldn't sleep in class or even get sick.

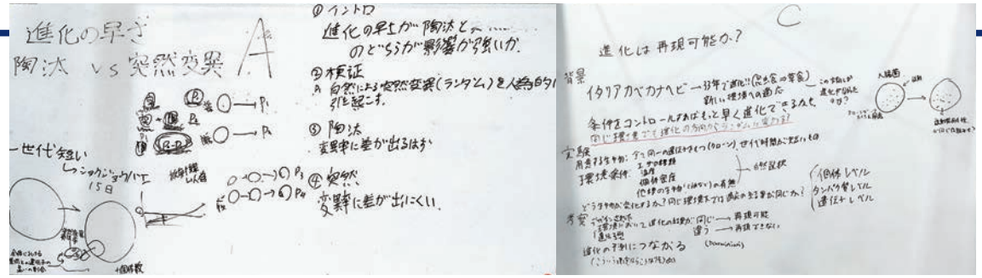
**•Do you feel different after spending time at iCeMS?**

**N:** Pioneering a new field and gaining results requires multidisciplinary collaboration. Gaining insight from experts can lead to unexpected and unique ideas.

**S:** All of the themes are complex and difficult, but seeing researchers devoted to their interests was an inspiration. I became more interested in biology and may take more courses on it in the future.

**T:** When we look for potential research material on the internet, oftentimes our ideas have been already published by someone else. I was surprised by the speed of science. I want to pursue biology, but knowledge of physics and chemistry is important.

**M:** The pharmaceutical science fuses biology and chemistry, but I think social demand is an equally defining factor for success in drug discovery.



A snippet from the last presentation class, titled "Evolution"

The four of us would argue and revise the teaching plan. In that sense, I felt like the course was alive.

**AJ** • This was possible because you didn't have a rigid teaching plan.

**SF** • That's what was great about it. Most of us are spontaneous, but I guess Kazuto is the most detail-oriented out of us.

**KF** • I'm a worrywart.

**KS** • Kazuto starts preparing three weeks in advance, so we said we have to decide on the themes before he starts preparing.

**KS** • If it were me and Shuhei, we would get too excited and overlook details.

**SF** • If Masakazu joined in, things would get out of control…

**KS** • So Kazuto gives a good balance.

**MH** • I am a 'bad influence'? Anyway, we are a well-balanced group.

**SF** • I should mention that the four of us know each other very well. At iCeMS, people from different disciplines interact on a daily basis.

**AJ** • As a communications researcher, I am absolutely delighted to hear that this course gave communication and respect for individuality the same degree of importance.

## Say what you think, but listen to others

**AJ** • So for every class, 16 students split up into four groups and had discussions?

**KS** • Yes. We mixed up the members each time, and it seemed the students changed their role depending on the type of people in the group.

**SF** • Japanese are good at reading between the lines. In this course, I suggested that it's important not to do that. Instead, listen to people intently, and say what you have to say.

**KS** • Masakazu and Shuhei said that innovation is brought about by those who do not read between the lines.

**AJ** • This message must have come as a shock for some students.

**SF** • Instead of trying to please people, state your honest opinion, and respect other opinions.

**MH** • There's an anecdote that innovation is brought about by inspiration, but that isn't always the case. Innovation is derived from communities and group societies, not isolated individuals.

**AJ** • A difficult theory to prove, but I guess you're right.

**MH** • In this age, information spreads quickly and globally, so there is a chance that amazing things emerge from the world looking in the same direction.

**AJ** • I guess reality is bound to exceed expectations.

**KS** • In the 1950's and 60's, the Biology Society of Japan argued about whether new concepts should be imported from overseas. Japanese academic societies and overseas societies existed as independent entities. But now, they are all interconnected.

**MH** • Plus, ways of retrieving literature changed over time. When I was a student, I used to go to the library to find a particular paper I was looking for, but now I don't go to the library because I can click on the screen from my office.

**KS** • Students in this course were also using their computers and smartphones to download documents and read papers that they searched for on their own.

**MH** • There are both pros and cons to taking charge of your own learning. When turning the pages in a library, you inevitably see things that aren't related to your field. Now, we search by keyword, so

we only see information acquired from a small domain.

**SF** ● Ideas don't formulate if you don't look for information broadly.

## Interdisciplinary science for future generations

**MH** ● Because information now spreads quickly and globally, amazing idea may emerge coincidentally.

**SF** ● When doing something new, you first need to take in as many facts as possible. Then you apply them. Students intake a ton of information in high school, so the question is, "how will I apply this knowledge at university?"

**KS** ● Students who took our course exceeded our expectations. They were like a breath of fresh air.

**SF** ● Once a week, I would spend time with the students and feel less jaded again.

**KS** ● I felt empty when it was all over. "No pocket seminar from next week…"

**AJ** ● Pocket-loss syndrome… The students would be happy to hear that.

**SF** ● The versatile format of the course allowed for interpretation and reconfiguration according to different age groups.

**KS** ● A myriad of expert advice helped to prepare the lesson course structure. In the future, we want to properly assess doctoral dissertations that are based on interdisciplinary research.

**SF** ● That is our exact aim.

**KS** ● We don't want to let interdisciplinary fusion be a passing fad. To develop it as a sustainable academic field, we need to develop the educational methodology to pass on this interdisciplinary scientific thinking to the next generation. This course was a touchstone of that effort, feasible because of iCeMS.

At the iCeMS Exhibition Lounge on November 16th, 2015

**MH** ● This course is perhaps not as easily taught at the School of Science and Engineering.

**SF** ● It is still possible. You just need to overcome disciplinary borders, and you need a collaborating partner.

**MH** ● "Interdisciplinary thinking" needs to be at the base. This fundamental component already existed in iCeMS, so everything else followed naturally.

## Meet prospective colleagues

**AJ** ● Some took the Pocket Seminars because of the closeness between students and professors.

**SF** ● The fundamental approach for courses offered at ILAS* from FY2016 is that they are participation centered and have a small class size. Relay lectures are not acceptable for these courses, which emphasize student-professor communication. "Keeping classroom learning to a minimum" is the general rule.

**KS** ● We went ahead and incorporated these ILAS principles.

**SF** ● There were two professors at most in other courses. We had four for every class. With so many professors with different personalities, it became an opportunity for students to broaden their perspectives.

**KF** ● Students may be confused about their direction in life, but there are no correct answers. The only thing that makes a difference is doing what you think is interesting.

**MH** ● In three or four years, these freshmen become fellow colleagues, doing experiments and having discussions in the same labs.

**KS** ● There were many things that students taught us throughout the course. On the last day, we asked them what they wanted to do. Some said they wanted to become a researcher, and others said they wanted to become a doctor. I am excited to see what kind of people they will become. One day, I can brag to people, "he/she was a student of mine."

**KF** ● They are bound for success.

**SF** ● I'm excited for their future.

* ILAS will offer courses from FY2016 by expanding courses offered as small-class education courses (pocket seminars).



# iCeMS in brief

• What's new? •


## Three iCeMS research teams participate in a public event at Kyoto University

On Kyoto University Academic Day, held at the Kyoto University Clock Tower Centennial Hall on October 4th, 2015, three groups from iCeMS participated in the "talking with researchers" program designed to promote dialogue with the general public. Members of the Susumu Kitagawa and Hiroshi Sugiyama groups and the Science Communication Group (SCG) engaged in discussions with visitors regarding "The World of Nanospace and Chemistry", "Creating Artificial DNA Switches", and "What is 'Good' Communication?"

## Yong Chen receives Nanoimprint Pioneer Award

Nanoimprint technology allows scientists to create very small architectures at the 100s nano-meter scale (0.0001 mm), which can be applied in the development of semiconductors, optical components, and bio-devices. Prof. Yong Chen of iCeMS received the Nanoimprint Pioneer Award at the 14th International Conference on Nanoimprint and Nanoprint Technology (NNT) for his great contribution to the development of this technology.

• Research Highlights •

Assoc. Prof. Tatsuya Murakami

## Intractable pain may find relief in tiny gold rods

Assoc. Prof. Tatsuya Murakami and his team have developed a novel technique using nano-meter size gold rods to target pain receptors. This technique could lead to therapies for pain relief in people with intractable pain, potentially including cancer-related pain.

From left: Dr. Yuki Suzuki, Assoc. Prof. Masayuki Endo, Prof. Hiroshi Sugiyama

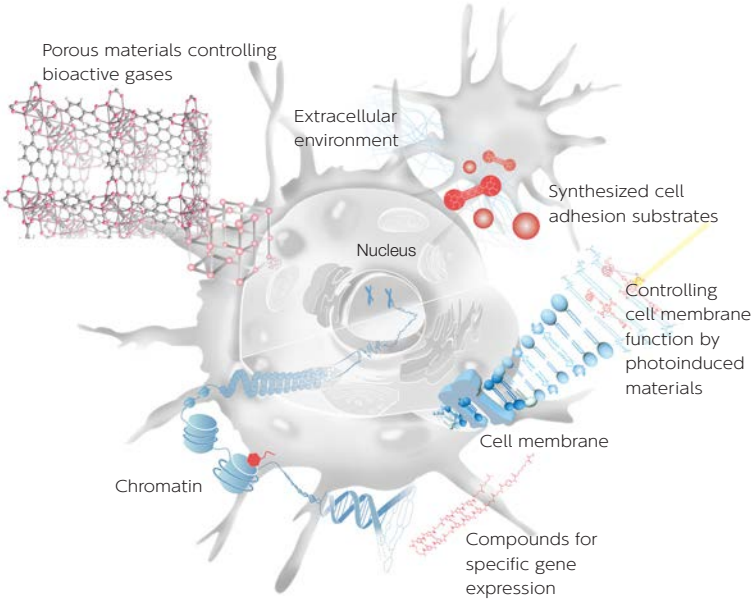
## Using DNA origami to build nanodevices of the future

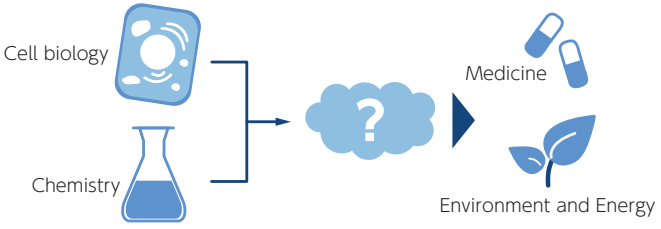
Prof. Hiroshi Sugiyama and his team have developed a method using a double layer of lipids, which facilitates the assembly of DNA origami units to bring us one-step closer to organized DNA nanomachines. This approach further expands the potential applications of DNA origami structures and their assemblies into the fields of nanotechnology, biophysics and synthetic biology.

# Groundbreaking research at the border between Materials and Life

At iCeMS, we develop new insights into the principles of life that distinguish living things from non-living things. We 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.

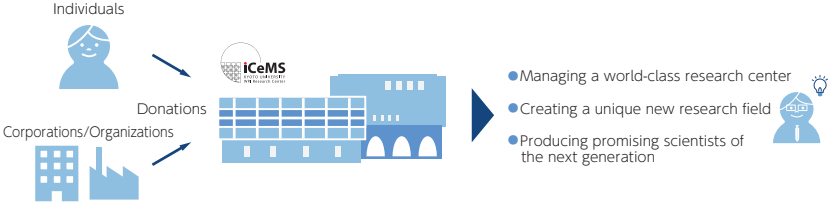
Whilst much of the work we do here at the Institute is pure science, we are absolutely certain that our research, combining high-level chemistry, cell biology and physics at the border between materials and life, will meaningfully impact the world in which we live.




## Help us grow

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




**http://www.icems.kyoto-u.ac.jp/e/fund/**

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