Spotlight on Research

2023-24 Hokkaido University

MARINE BACTERIA
take a bite at plastic pollution

Miocene period fossil
FOREST OF WATARIA
found in Japan

Smart Agriculture Education and Research Center
INAUGURATED

Hokkaido University &
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COLLABORATIONS

Turning
PLASTIC TRASH
into chemistry treasure

Uracil found in
RYUGU SAMPLES

HOKKAIDO UNIVERSITY

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Turning plastic trash into chemistry treasure

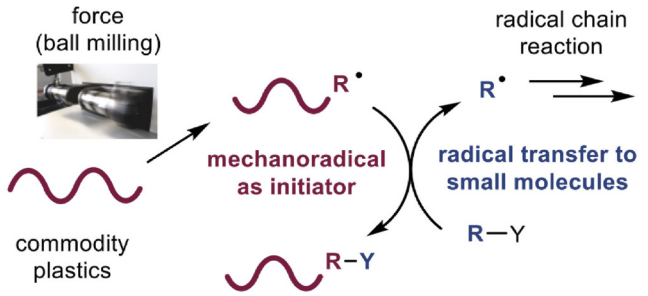
Researchers employ common plastics to kickstart radical chain reactions, creating a way to reuse plastic waste while improving process safety and efficiency.

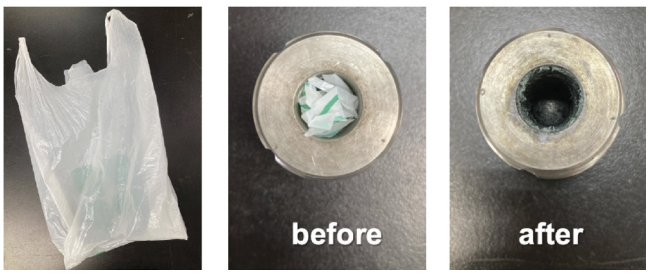
Single-use plastics are a major environmental concern, but now, rather than being disposed of as garbage, used plastic bags from the grocery store could be utilized to carry out a reaction that can detoxify hazardous chemicals.

A team led by researchers at the Institute for Chemical Reaction Design and Discovery (WPI-ICReDD), Hokkaido University has developed a method that uses common plastic materials instead of potentially explosive compounds to initiate radical chain reactions. This approach significantly increases the safety of the process while also providing a way to reuse common plastics such as polyethylene and polyvinyl acetate. These findings have been published in the *Journal of the American Chemical Society*.

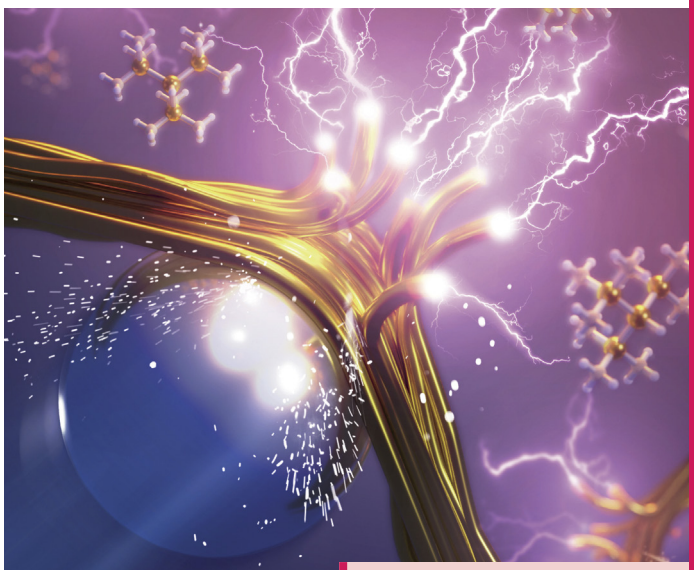
Researchers utilized a ball mill, a machine that rapidly shakes a steel ball inside a steel jar to mix solid chemicals. When the ball slams into the plastic, the mechanical force breaks a chemical bond to form radicals, which have a highly reactive, unbonded electron. These radicals facilitated a self-sustaining chain reaction that promotes dehalogenation— *i.e.*, the replacement of a halogen atom with a hydrogen atom—of organic halides.

"The use of commodity plastics as chemical reagents is a completely new perspective on organic synthesis," said Associate Professor Koji Kubota. "I believe that this approach will lead to not only the development of safe and highly efficient radical-based reactions, but also to a new way to utilize waste plastics, which are a serious social problem."





(Top) General scheme for using mechanical force to trigger a radical chain reaction. (Bottom) Shreds of a grocery bag were utilized to initiate a reaction in a ball mill jar. (Koji Kubota, et al. *Journal of the American Chemical Society*. December 22, 2023)



Artistic depiction of extremely reactive molecules called radicals being generated from plastic fibers. Illustration: Koji Kubota and Hajime Ito

The reuse of waste plastic was demonstrated by adding plastic shreds of a common grocery bag to the ball mill jar and successfully carrying out the reaction. The team also showed their method could be applied to the treatment of highly toxic polyhalogenated compounds, which are widely used in industry. Polyethylene was employed to initiate a radical reaction that removed multiple halogen atoms from a compound commonly used as a flame retardant, thus reducing its toxicity.

Researchers anticipate this method will garner the attention of industry due to advantages in cost and safety.

"Our new approach using stable, cheap and abundant plastic materials as initiators for radical chain reactions holds the significant potential to foster the development of industrially attractive, safe and highly efficient chemical processes," commented Professor Hajime Ito. ●

ORIGINAL ARTICLE
Koji Kubota, et al. Using Mechanochemistry to Activate Commodity Plastics as Initiators for Radical Chain Reactions of Small Organic Molecules. *Journal of the American Chemical Society*. December 22, 2023.

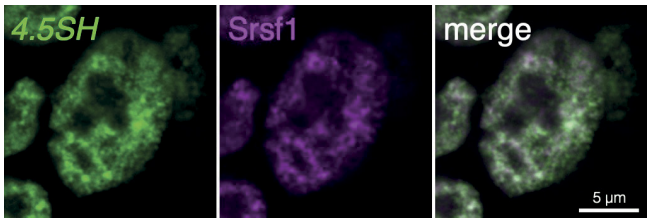
FUNDING
JSPS KAKENHI (22H00318, 21H01926, 22K18333, 22H05328); JST CREST (JPMJCR19R1) and JST FOREST (JPMJFR201I); WPI-ICReDD.

CONTACT
**Associate Professor Koji Kubota
Institute for Chemical Reaction Design and Discovery (WPI-ICReDD)
Hokkaido University
kbt@eng.hokudai.ac.jp**

**Professor Hajime Ito
Institute for Chemical Reaction Design and Discovery (WPI-ICReDD)
Hokkaido University
hajito@eng.hokudai.ac.jp**

Mice possess natural gene therapy system

A previously mysterious small RNA molecule in mice is found to play a crucial role in gene expression, and may be the first identified member of a new class of regulatory RNAs.



4.5SH RNA (green) is located in the nuclear speckles (Srsf1, magenta)—structures in the cell nucleus associated with gene expression—in embryonic stem cells, where it plays an essential role in RNA processing. (Rei Yoshimoto, et al. *Molecular Cell*. December 13, 2023)

RNA (ribonucleic acid) is best known as the messenger RNA (mRNA) that carries a copy of a gene's information out from the cell nucleus to where it can be decoded to make protein molecules. But RNA also performs other key functions, including the regulation of gene activity by a variety of small non-coding RNAs—those whose genetic sequence is not used to generate proteins.

One such non-coding RNA is the small RNA called 4.5SH, found only in small rodents including mice and rats. It is produced from multiple copies of its gene, leading to the accumulation of up to 10,000 copies of the RNA molecule per cell.

A team of researchers led by Professor Shinichi Nakagawa at Hokkaido University has discovered a new role for 4.5SH RNA—circumventing mutations in mouse DNA during the maturation of mRNA. Their findings were published in the journal *Molecular Cell*.

"4.5SH RNA was discovered in the 1970s, yet despite its abundance and presence in many types of tissues, its function had remained a mystery for over 40 years," says Nakagawa.

To understand its role, the researchers created mutations in mouse embryos that abolished 4.5SH production, discovering that this caused early death at the embryo stage.

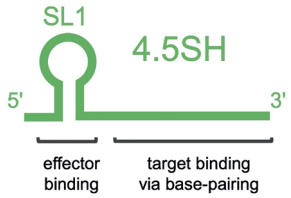
"It was known that the mouse genome has many lethal mutations in genes that code essential proteins," explains Nakagawa. "4.5SH RNA has the ability to detoxify these mutations in bulk—essentially, it is a natural gene therapy to protect against mutations."

Analysis of the structure of 4.5SH RNA showed that it is composed of two modules. One serves as a sensor to find abnormal sequences, and the other brings in a tool that prevents the incorporation of the abnormal sequences into mRNA by a process called alternative splicing.

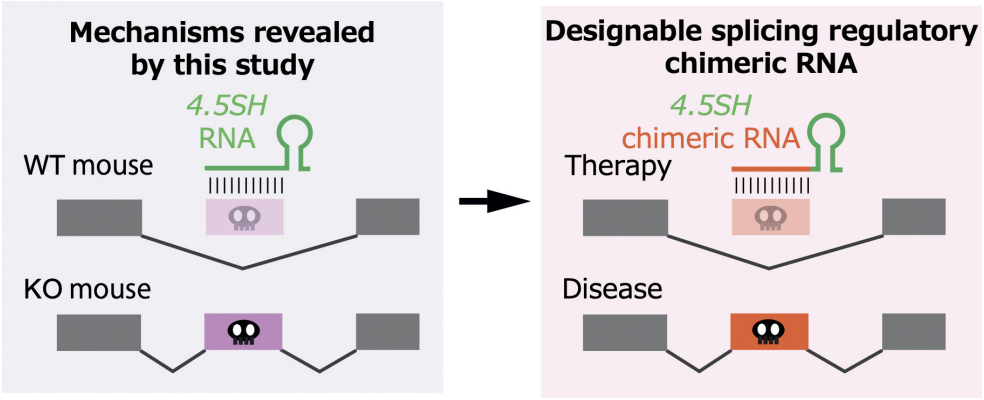
"To our knowledge, this is the first example of a naturally produced RNA that can regulate alternative splicing in a definitive on/off manner," says Nakagawa. "Our research also suggests that a substantial portion of such non-coding RNAs may be involved in controlling alternative splicing."

The researchers were also able to use 4.5SH to design a programmable molecular system that could manipulate splicing in cells in selected ways. This might become a new and useful tool for genetic engineering.

"Our discovery suggests the possibility of developing new gene therapy drugs that recognize only specific genetic mutations by modifying the sensor module of 4.5 SH RNA, so we may be able to prevent toxic regions associated with disease from being expressed," Nakagawa explains. ●



Modular structure of 4.5SH RNA. The sensor module (target binding via base-pairing) recognizes and binds to abnormal sequences. The effector binding module brings in molecules that modulate alternative splicing to prevent incorporation of abnormal sequences in mRNA. (Illustration: Shinichi Nakagawa).



In mice, 4.5SH RNA acts as a natural gene therapy agent, preventing the inclusion of mutations in RNA (left). By engineering recombinant 4.5SH RNA, it may be possible to apply this system to treat genetic diseases in humans (right). (Illustration: Shinichi Nakagawa).

ORIGINAL ARTICLE
Rei Yoshimoto, et al. 4.5SH RNA counteracts deleterious exonization of SINE B1 in mice. *Molecular Cell*. December 13, 2023.

FUNDING
JSPS KAKENHI (JP16H06276, 21H05274, 21K19246, 22K05565, 21H00253, 22H02545, JP20H05784); AMED (P23ym0126801); Hokkaido University.

CONTACT
Professor Shinichi Nakagawa
Faculty of Pharmaceutical Sciences
Hokkaido University
nakagawas@pharm.hokudai.ac.jp

ISSA-KUN, the artificial intelligence haiku poet

Associate Professor Tomohisa Yamashita and his colleagues at the Laboratory of Harmonious Systems Engineering (Harmo Lab, Faculty of Information Science and Technology) devote their research to Artificial Intelligence (AI) for the benefit of human happiness. One of their breakthroughs is the birth of Issa-kun, a haiku generator.

In 2017, the research team of the laboratory started a new project upon having received a peculiar challenge: to create an AI that can compose haiku verses. Haiku is a specific form of Japanese poetry consisting of 5-7-5 phonetic units (or syllables).

Issa-kun's machine learning (language model) learns from a set of data registered in its system as "training data." Some of the training data are taken from haiku of the old literary masters such as Kyoshi Takahama and Issa Kobayashi; the latter is the namesake of this AI. The early form of the model (Baby Issa-kun) analyzed the data in hiragana-only and produced phrases in hiragana in return, so some of the generated phrases were incoherent. The more advanced model (Adult Issa-kun) was introduced to kanji characters.

"However, there were still some flaws when we first introduced kanji. This is because the language changes over time. Some language aspects used by the old masters differ from our time," said Yamashita. He took an example of an almost-obsolete kanji, 椛 (Momiji, Japanese maple), that once was used by Issa-kun.

Furthermore, Yamashita pointed out that when a person compose a haiku, they started out with the sentiment or message before moving on to selecting the words that best convey that. However, Issa-kun merely imitated the connections of the words from the training data. As a result, although Issa-kun can generate coherent phrases, not all have poetic value.

The research team was largely helped by haiku communities. They further fed the training data from haiku created by contemporary poets by attending (and hosting) haiku gatherings and other haiku or poetry-related events. The participants also assessed Issa-kun's verses; from this the research team can evaluate the model and remove unqualified verses.

In 2018, a television station offered the research team a chance to appear with Issa-kun on a television program. In this program, the AI was pitted against a human in creating a haiku. This propelled Issa-kun's fine-tuning that eventually resulted in Issa-kun becoming able to generate thematic haiku derived from images—though human intervention is still needed to review their qualities.

The ubiquitous presence of AI in our lives invites polarizing attitudes and opinions; however, Yamashita believes that AI should be utilized as a tool to reach and improve human happiness. This also covers the subjects of art and literature—poetry included—which have the power to provoke human emotions.

"Just like other technologies, Issa-kun is a tool. For example, some modern musicians use synthesizer, in real musical instrument's stead, to make good music. Issa-kun should be considered in such light. The combination of human creativity and Issa-kun's ability should make original and good haiku. That is the kind of human-AI harmony that we wish to reach," Yamashita commented.

Issa-kun is an ongoing collaboration with a Sapporo-based enterprise dealing with AI-related technologies and their promotion: Sapporo AI Lab. The laboratory is involved in multiple enterprise-academia collaborations, working on many other AI projects that can advance human life in different life aspects. ●

Photo of the Harmo Lab research team.

二人出て
水のつめたき
春の川

天心に
川を引くなり
秋の風

An image prompt used for the haiku recital event at the 29th National Haiku Contest at Basho Festival, Yamanaka Onsen (left). Two haiku submitted for the contest, generated by Issa-kun (above). Image and haiku provided by Harmo lab.

CONTACT
Laboratory of Harmonious Systems Engineering (Harmo Lab)
Faculty of Information Science and Technology
http://harmo-lab.jp/ (website in Japanese)

Nematodes joy ride across electric voltages

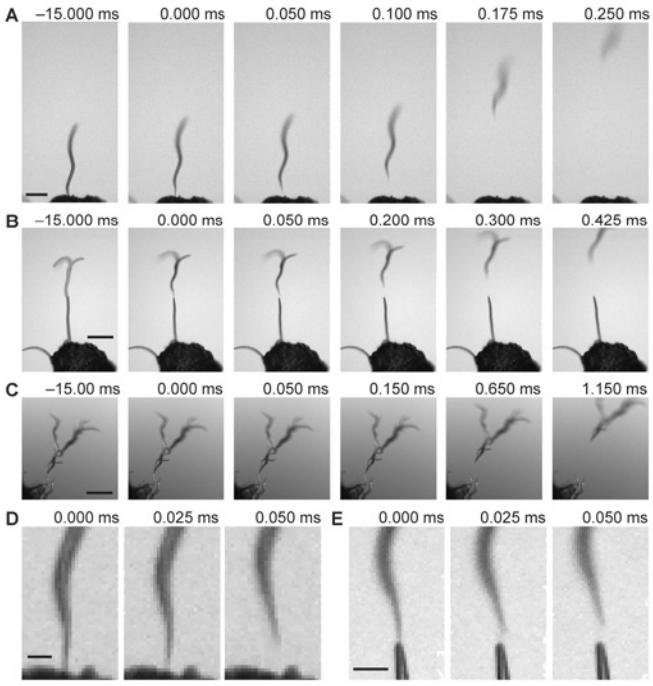
Hokkaido University researchers found that tiny nematode worm larvae surf electric fields to hitch rides on passing insects.

Many living organisms are known to make use of electric fields. Some fish species use them to detect predators or prey, and insects such as bees use them to attract pollen while foraging. Now, a research group including scientists from Hokkaido University has discovered that juvenile nematode worms can surf electric fields to leap through the air and hitch a ride on passing insects. Their findings have been published in the journal *Current Biology*.

Nematodes are one of many species that rely on larger animals to help them travel and disperse, an interaction called phoresy. They have been observed lifting themselves up on the tips of their tails (nictation), thus reducing their surface connection, to make it easier to attach themselves to a passing organism.

To explore how they achieve this, the research team bred the nematode worm *Caenorhabditis elegans* on dog food in a petri dish. They noticed that the larvae of the nematode, called dauer larvae, consistently moved to the lid of the dish. Some of the larvae reached the lid by crawling up the side of the dish, and others appeared on the lid in a fraction of a second.

"To more directly confirm the leap of *C. elegans* dauer larvae and to see how the worms leap in the dish and the characteristics of the leaping action, we observed a worm leaping in the Petri dish with a high-speed camera," says Associate Professor Katsuhiko Sato at the Research Institute for Electronic Science, Hokkaido University, corresponding author of the study.



Nictation and leaping of dauer larvae under an electric field. Top row, single dauer larva; middle row, two dauer larvae; bottom row, a group of dauer larvae. (Takuya Chiba et al. *Current Biology*. July 10, 2023)

> "... *C. elegans* uses electric interactions to attach to insects ... in the wild."

This showed that the larvae kept its body quite straight before the leap, and a single dauer larvae engaged in this behavior could also carry several other larvae with it in a leap.

The research team speculated that the nematode larvae might be using electrostatic forces to travel across the millimeters-wide gap between the substrate and the lid of the petri dish. They set up an experiment using a petri dish filled with agar and studded with tiny glass electrodes, with a separate glass electrode set up parallel to it. The larvae were placed on the agar, and the researchers applied different voltages to the two sets of electrodes to see how the larvae would behave.

When no electric charge was applied, the larvae did not leap. But when an electric field above a certain voltage was applied, the nematodes leapt from one electrode to another at an average speed just under one meter per second.

They then performed a second experiment using the bumblebee *Bombus terrestris*, which is known to use electrostatic charge to help it collect pollen, and saw the same leaping behavior when the bumblebee came within one to two millimeters of the nematode larvae.

"Although *C. elegans* has not been reported to attach to bees, it is known to attach to flying insects such as moths and flies in the wild," Sato notes. "We assume that *C. elegans* uses electric interactions to attach to insects, including bumblebees, in the wild." ●

ORIGINAL ARTICLE
Takuya Chiba et al. *Caenorhabditis elegans* transfers across a gap under an electric field as dispersal behavior. *Current Biology*. July 10, 2023.

FUNDING
The Japan Science Society; KAKENHI (20K03871, 18H01135); Hokkaido University; JSPS KAKENHI (19KK0180, 21H05308, 21H02532, JP18H05474, JP23H03845), Core-to-Core Program; the NJRC Mater. & Dev.; AMED (JP22gm6110022h9904); JST-Mirai (JPMJMI22G3); JST-FOREST (JPMJFR214R).

CONTACT
**Associate Professor Katsuhiko Sato
Research Institute for Electronic Science
Hokkaido University
katsuhiko_sato@es.hokudai.ac.jp**


Jian Ping Gong

Professor Jian Ping Gong of the Faculty of Advanced Life Science and of the Institute for Chemical Reaction Design and Discovery (WPI-ICReDD) won the Polymer Physics Prize from the American Physical Society (APS). The Polymer Prize is considered one of the highest awards in polymer science, globally. Gong received the award "for outstanding contributions to the understanding of mechanical and fracture properties of hydrogels based on novel network architectures and for discovering the concept of double network gels based on internal overstressed sacrificial bonds."


Hiroki Shirato

Distinguished Professor Hiroki Shirato of the Global Center for Biomedical Science and Engineering, Faculty of Medicine, was elected as a new member of the Japan Academy. The Japan Academy is an organization that honors scientists with outstanding academic achievements. Its members are also selected from among scientists possessing distinguished academic records. Shirato has pioneered a new field of cancer radiotherapy, having played a key role in developing 4D radiotherapy treatment. He has also made significant contributions to the development of radiation science and technology, from the conception and development of treatment devices to the approval of medical devices, insurance coverage, and overseas deployment.

AWARDS & RECOGNITIONS
received by Researchers at Hokkaido University

Associate Professor Masaaki Kitajima of the Faculty of Engineering has been awarded a Japan Open Innovation Prize alongside colleagues Hiroyuki Kobayashi at Shionogi & Co. Ltd., and Ryo Iwamoto at AdvanSentinel Inc. The Japan Open Innovation Prize was instituted in 2019 to further promote open innovation in Japan. Kitajima and colleagues were recognized for their contribution to the practical application of wastewater-based epidemiology (WBE) for tracking COVID-19.


Masaaki Kitajima

Kitajima has also been recognised as a Highly Cited Researcher by Clarivate, for the second year in a row. The Highly Cited Researchers are scientists who have published several papers in the top 1% of all papers cited worldwide and have demonstrated significant and broad influence in their chosen field or fields of research. Kitajima was again recognised for the impact of his work in the field of Environment and Ecology.

Kitajima, Shionogi & Co., and AdvanSentinel Ltd. were bestowed with the Minister of State for Health and Medical Strategy Award of the 6th Japan Medical Research and Development Grand Prize. The award was granted in recognition of their initiative "Implementation of Wastewater-based Epidemiology for Novel Coronavirus." The Japan Medical Research and Development Awards are given to universities, public research institutions, companies and other organizations that have made a significant contribution to the promotion of research and development in the medical field by achieving groundbreaking and important results, and by developing practical application of the results of such research and development.

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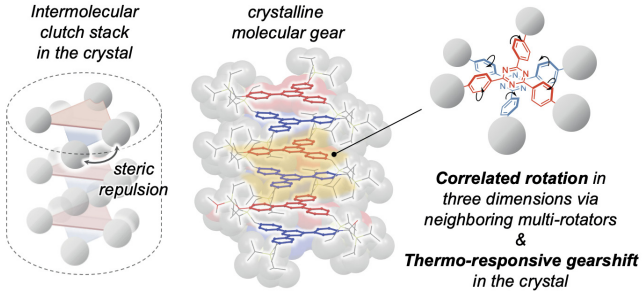
Controllable shifting of molecular gears could drive material innovation

Temperature-controlled, reversible shifting of molecular gear motion in a solid crystal opens new possibilities for material design.



(Left) Schematic of the clutch stack arrangement. (Middle) Structure of the molecular gears in the clutch stack. (Right) Rotational direction of two adjacent molecular gears. (Mingoo Jin, et al. *JACS*. December 7, 2023)

Gears are an essential component of everyday machines. The ability to shift gears, like in a car, allows for control of the degree or direction of motion generated, making machines more versatile. Now, a team led by researchers at the Institute for Chemical Reaction Design and Discovery (WPI-ICReDD) in Hokkaido University has reported the first example of controllable molecular gear shifting in a solid material. They developed a crystalline material that contains gear-like molecules which can be reversibly shifted between two types of motion. The design principle provides a blueprint for the development of versatile, new materials.

Researchers utilized a gear-shaped molecule called triaryltriazine, which has a center triazine ring with three phenylene rings attached to it—which act like the teeth of a gear. By attaching bulky, stationary molecules to the phenylene rings, researchers induced a "clutch stack" arrangement, where adjacent triaryltriazine molecules are rotated 60° from each other, rather than stacking in the same orientation.

"The design of the clutch stack was inspired by the mechanical machinery system of the clutch in a car," said Associate Professor Mingoo Jin.

The attached stationary molecules also created enough space for the three phenylene rings to rotate between two positions in a flapping motion. The clutch stack arrangement of the triaryltriazine molecules enabled adjacent molecules to hook into each other as the phenylene rings rotated, much like interlocking gears. This resulted in the correlated motion of all the molecules in the stack.

When the temperature was raised above a certain threshold, a different correlated motion was observed, in which phenylene rings underwent a 180° rotation. This change in motion was attributed to a phase transition in the crystal that created more space between adjacent molecules, giving the phenylene rings more room to rotate.

Researchers found this change in motion could be reversed by cooling the crystal, marking the first time such controllable molecular motion has been observed in a solid. The effect of the molecular gearshift could be fine-tuned by adjusting the size and structure of the stationary molecule attached to the gear molecule. This adjustability opens the door to the development of new functional materials that leverage crystalline molecular machines.

"The next direction for our research would be using geared molecular motion in crystals to manipulate different physical properties of solid-state materials, such as light emission or thermal behavior" commented Jin.

ORIGINAL ARTICLE
Mingoo Jin, et al. A Steric-Repulsion-Driven Clutch Stack of Triaryltriazines: Correlated Molecular Rotations and a Thermo-Responsive Gearshift in the Crystalline Solid. *Journal of the American Chemical Society*. December 7, 2023.

FUNDING
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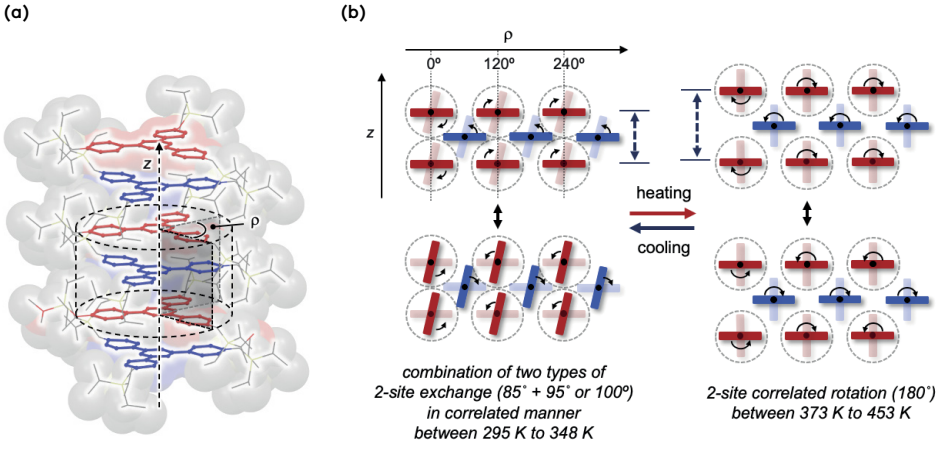
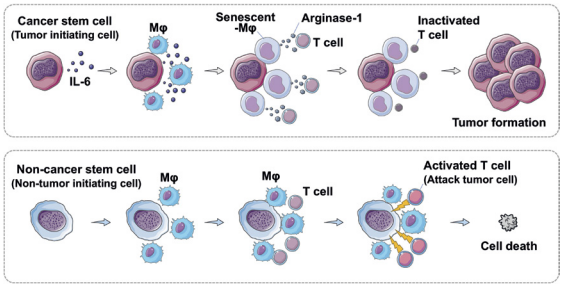
CONTACT
**Associate Professor Mingoo Jin
Institute for Chemical Reaction Design and Discovery (WPI-ICReDD)
Hokkaido University
mingoo@icredd.hokudai.ac.jp**



(Left) Schematic of the clutch stack arrangement. (Middle) Structure of the molecular gears in the clutch stack. (Right) Rotational direction of two adjacent molecular gears. (Mingoo Jin, et al. *JACS*. December 7, 2023)

Cancer stem cells trigger macrophage aging

Cancer stem cells cause the aging of macrophages in mice with healthy immune systems, creating conditions for the formation of tumors.



(Top) Cancer stem cells produce interleukin-6 (IL-6), which induces senescence in macrophages (MΦ). In turn, these produce arginase-1 and inactivate T cells. As a result, cancer cells are not killed by immune system cells, leading to tumor formation. (Bottom) Non-cancer stem cells do not produce IL-6. Macrophages do not age and T cells are activated. Activated T cells destroy cancer cells, preventing tumor formation. (Illustration: Haruka Wada).

Cancerous tumors consist of a mixture of cells, the most important of which are cancer stem cells. These cells are capable of establishing new cancerous tumors by evading the immune response. Research has focused on identifying biomarkers for cancer stem cells and developing therapies that target these cells. Unfortunately, candidate drugs developed from these efforts have so far not been very effective in clinical trials.

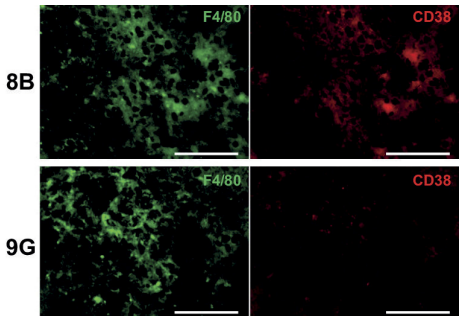
A research team led by Associate Professor Haruka Wada at Hokkaido University's Institute for Genetic Medicine examined the mechanisms by which cancer stem cells evade immune response in mice models. They showed that cancer stem cells induce senescence in macrophages—the immune cells which are responsible for the first step of the destruction of cancer cells. Their findings were published in the *Journal for ImmunoTherapy of Cancer*.

"One of the biggest questions in the development of cancer is how cancer develops in individuals with a healthy immune system," explains Wada. "The majority of studies on cancer stem cells have been carried out in vitro or in immunodeficient mice models, which do not account for a fully functioning immune response. The lack of effectiveness of cancer stem cell-targeting drugs indicates that the immune response or lack thereof is more important than previously considered."

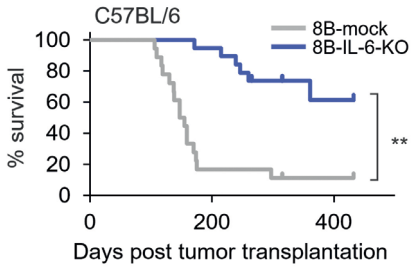
The team used two cell lines of glioblastoma tumor, one of which was capable of inducing tumor formation (cancer stem cell) and the other of which was not. In mice models, the cancer stem cells suppressed the proliferation of macrophages; further investigation showed that macrophages cultured with cancer stem cells exhibit senescence or cellular aging. Macrophages were not the only immune cells affected; while the proliferation of T cells was unchanged, their antitumor activity was suppressed due to the immunosuppressive factors produced by senescent macrophages. The team identified interleukin 6 (IL-6) produced by cancer stem cells as the molecule responsible for triggering these effects.

The team also demonstrated that supplementing the mice inoculated with cancer stem cells with a molecule called nicotinamide mononucleotide resulted in the proliferation of non-senescent macrophages and reduced the immunosuppressive factors produced by senescent macrophages, preventing tumor growth and leading to increased survival times in mice.

"Our results indicate that drugs targeting senescent macrophages could be a treatment for cancer—an unprecedented development," concluded Wada. "We believe that these drugs could be part of a treatment that prevents the new onset of tumors, as well as a therapy that prevents recurrence after cancer treatment." Future work will focus on two avenues: confirming that this discovery holds true for cancers other than glioblastomas, and confirming that the findings apply to cancers in humans. ●



Cancer stem cells (8B, top row) and noncancer stem cells (9G, bottom row) are associated with similar numbers of macrophages (F4/80); however, a much greater proportion of macrophages associated with cancer stem cells are senescent (CD38). (Haruka Wada, et al. *Journal for ImmunoTherapy of Cancer*. November 14, 2023)



When cancer stem cells modified to be unable to express interleukin-6 (8B-IL-6-KO) were transplanted into immunocompetent mice (C57BL/6), survival times of the mice increased significantly compared to mice that were transplanted with cancer stem cells that express IL-6 (8B-mock). (Haruka Wada, et al. *Journal for ImmunoTherapy of Cancer*. November 14, 2023)

ORIGINAL ARTICLE
Haruka Wada, et al. Tumor cell-induced macrophage senescence plays a pivotal role in tumor initiation followed by stable growth in immunocompetent condition. *Journal for ImmunoTherapy of Cancer*. November 14, 2023.

FUNDING
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CONTACT
Associate Professor Haruka Wada
Institute for Genetic Medicine
Hokkaido University
wada@igm.hokudai.ac.jp

Training Ship Oshoro-Maru completed an Arctic tour

Oshoro-Maru, the largest training vessel owned by the Faculty of Fisheries Sciences, departed from Hakodate Port on June 8th, 2023, and returned on August 3rd, 2023. The ship sailed through the Bering Sea and Chukchi Sea, carrying students and researchers from not only Hokkaido University, but also from other universities and research institutions. This marks Oshoro-Maru's first expedition abroad in 5 years. During both the outbound and return trip, the ship made stops at Nome, Alaska.

The current Oshoro-Maru is the fifth generation of the training vessel. Completed in 2014, the ship is equipped with an ice-resistant structure for navigation in the subarctic zone, making it a suited vessel for this 57-day expedition. This research voyage was supported by Arctic Challenge for Sustainability II (ArCS II), a project led by the National Institute of Polar Research (NIPR), the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and Hokkaido University.

Oshoro-Maru departed from Hakodate Port
Photo: Umi Ezawa, Hakodate Campus Administrative Office

Attendees of the 14th Annual ISAJ Symposium. Photo: Sohail Keegan Pinto

Indian Scientists Association in Japan 14th Annual Symposium held at Hokkaido University

The 14th Annual Symposium of the Indian Scientists Association in Japan (ISAJ), with the theme Integrated Science for a Sustainable Society, was held at Hokkaido University on November 10, 2023. The symposium consisted of a full day of interdisciplinary sessions encompassing various fields of science and technology. A major objective of the symposium was to create an opportunity for students and young scientists in Japan, to showcase their research, exchange ideas, and foster collaborations.

The symposium was taken up by four sessions, each with a mix of keynote and invited speakers. About half the invited speakers were young scientists early in their careers. A luncheon seminar on pursuing a research career in Japan, for the student participants in the symposium, and a poster presentation session were also held.

Ryuzo Yanagimachi awarded the prestigious Kyoto Prize

Ryuzo Yanagimachi, a reproductive embryologist and a graduate of Hokkaido University, was awarded the Kyoto Prize for his contributions to the elucidation of fertilization mechanisms and the establishment of micro-insemination technology.

Throughout his career, Yanagimachi and his team made significant contributions to the development of livestock farming and human-assisted reproductive technology (ART). In particular, he established a reproducible method for in vitro fertilization (IVF) in mammals, which also advanced the development of IVF technology in humans. He is also known for developing and improving a method called intracytoplasmic sperm injection (ICSI), which directly injects sperm into egg cytoplasm to achieve fertilization. His team also successfully created cloned mice by transferring somatic cell nuclei into egg cells.

Founded in 1984 by Kazuo Inamori, the Kyoto Prize is an international award that honors individuals who have made significant contributions in the fields of science and technology, as well as arts and philosophy.

Dr. Yanagimachi passed away in September 2023, at the age of 95, before he received the prize.

Ryuzo Yanagimachi visited Hokkaido University's School of Science in 2022. Photo courtesy of Like! Hokudai

The annual Hokkaido Indonesian Student Association Scientific Meeting (HISAS) returns

Hokkaido University Ambassador Dr. Christofora Hanny Wijaya delivering the final presentation during HISAS.

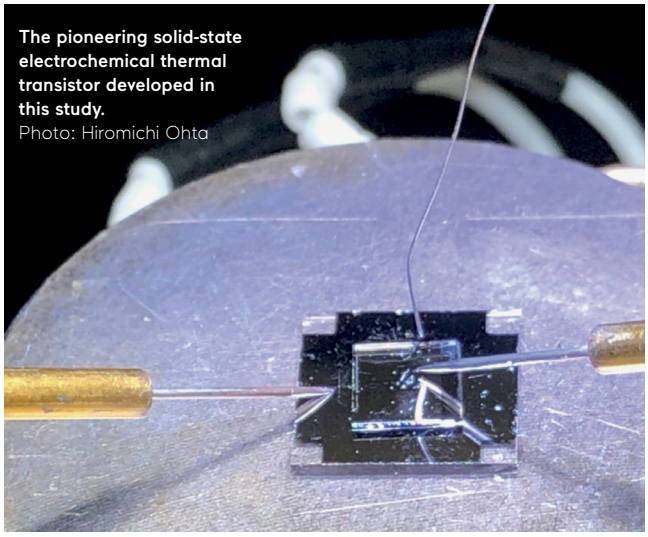
After a 4-year long interruption due to COVID-19, the annual Hokkaido Indonesian Student Association Scientific Meeting (HISAS) has been revived to its usual on-site-only format for its 18th year. On June 17, 2023, seventy participants gathered attending lectures and joining discussions on "Harmonization of Cutting-Edge Food Research with Ecological and Social Considerations."

Organized by Indonesian Student Association of Hokkaido (PPI-H), HISAS was first carried out in the year 2001. The annual scientific meeting is open for participation from researchers and students of any background and region of the world.

Participants attended three lectures, which explored the scientific discoveries and the potential applications in food production. These were followed by presentations, divided into three parallel sessions based on the research topic: agriculture, fisheries, and animal sciences. Moderated by the invited experts, the sessions produced knowledge exchange between the young and more experienced researchers.

Solid-state thermal transistor demonstrated

An effective, stable solid-state electrochemical transistor has been developed, heralding a new era in thermal management technology.



The pioneering solid-state electrochemical thermal transistor developed in this study.
Photo: Hiromichi Ohta

In modern electronics, a large amount of heat is produced as waste during usage—this is why devices such as laptops and mobile phones become warm during use, and require cooling solutions. In the last decade, the concept of managing this heat using electricity has been tested, leading to the development of electrochemical thermal transistors—devices that can be used to control heat flow with electrical signals. Currently, liquid-state thermal transistors are in use, but have critical limitations: chiefly, any leakage causes the device to stop working.

A research team at Hokkaido University led by Professor Hiromichi Ohta at the Research Institute for Electronic science has developed the first solid-state electrochemical thermal transistor. Their invention, described in the journal *Advanced Functional Materials*, is much more stable than, and just as effective as, current liquid-state thermal transistors.

"A thermal transistor consists broadly of two materials, the active material and the switching material," explains Ohta. "The active material has changeable thermal conductivity (κ), and the switching material is used to control the thermal conductivity of the active material."

The team constructed their thermal transistor on a yttrium oxide-stabilized zirconium oxide base, which also functioned as the switching material, and used strontium cobalt oxide as the active material. Platinum electrodes were used to supply the power required to control the transistor.

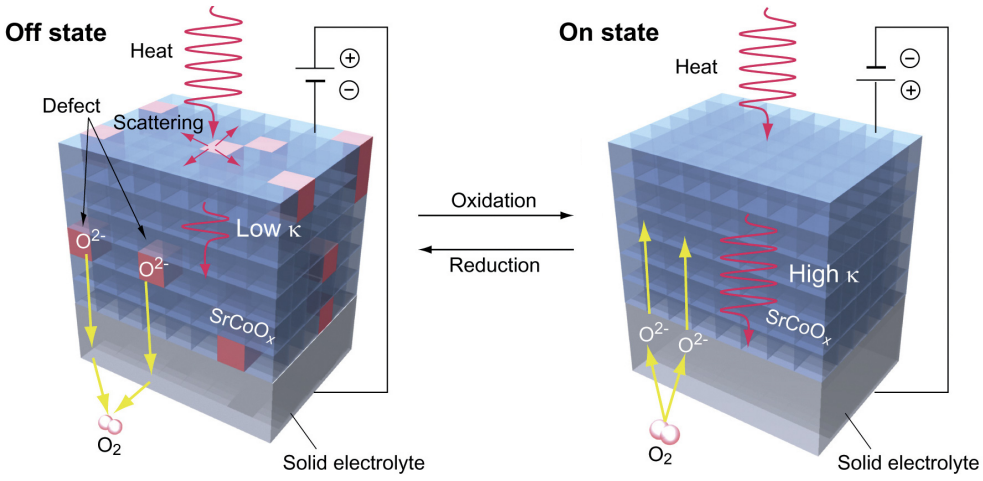
The thermal conductivity of the active material in the "on" state was comparable to some liquid-state thermal transistors. In general, thermal conductivity of the active material was four times higher in the "on" state compared to the "off" state. Further, the transistor was stable over 10 use cycles, better than some current liquid-state thermal transistors. This behavior was tested across more than 20 separately fabricated thermal transistors, ensuring the results were reproducible. The only drawback was the operating temperature of around 300°C.

"Our findings show that solid-state electrochemical thermal transistors have the potential to be just as effective as liquid-state electrochemical thermal transistors, with none of their limitations," concludes Ohta. "The main hurdle to developing practical thermal transistors is the high resistance of the switching material, and hence a high operating temperature. This will be the focus of our future research." ●

ORIGINAL ARTICLE
Qian Yang, et al. Solid-State Electrochemical Thermal Transistors. *Advanced Functional Materials*. February 21, 2023.

FUNDING
JSPS (22H00253, 19H05791, 19H05788, 21J10042); the Crossover Alliance to Create the Future with People, Intelligence and Materials; NJRC for Materials and Devices; MEXT (JPMXP1222UT0055); Hokkaido University.

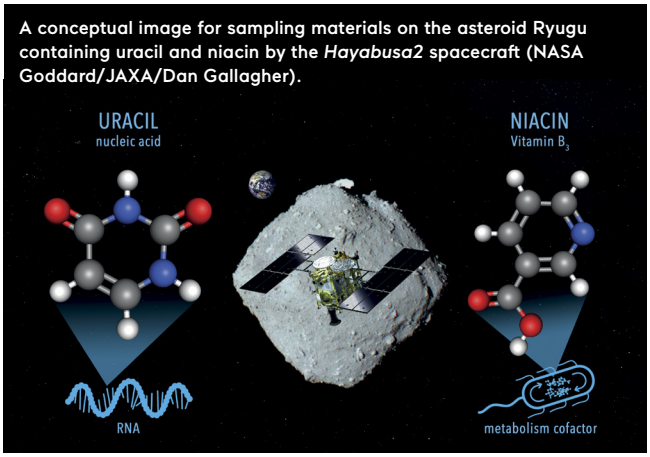
CONTACT
**Professor Hiromichi Ohta
Research Institute for Electronic Science
Hokkaido University
hiromichi.ohta@es.hokudai.ac.jp**



Design of a solid-state electrochemical thermal transistor. In the "off" state (left), the active material has reduced oxygen, which reduces its thermal conductivity. In the "on" state (right), the active material is rich in oxygen, greatly increasing its thermal conductivity. (Qian Yang, et al. *Advanced Functional Materials*. February 21, 2023).

Uracil found in Ryugu samples

Samples from the asteroid Ryugu collected by the *Hayabusa2* mission contain nitrogenous organic compounds, including the nucleobase uracil, which is a part of RNA.



A conceptual image for sampling materials on the asteroid Ryugu containing uracil and niacin by the *Hayabusa2* spacecraft (NASA Goddard/JAXA/Dan Gallagher).

Researchers have analyzed samples of asteroid Ryugu collected by the Japanese Space Agency's *Hayabusa2* spacecraft and found uracil—one of the informational units that make up RNA, the molecules that contain the instructions for how to build and operate living organisms. Nicotinic acid, also known as Vitamin B_3 or niacin, which is an important cofactor for metabolism in living organisms, was also detected in the same samples.

This discovery by an international team, led by Associate Professor Yasuhiro Oba at Hokkaido University, adds to the evidence that important building blocks for life are created in space and could have been delivered to Earth by meteorites. The findings were published in the journal *Nature Communications*.

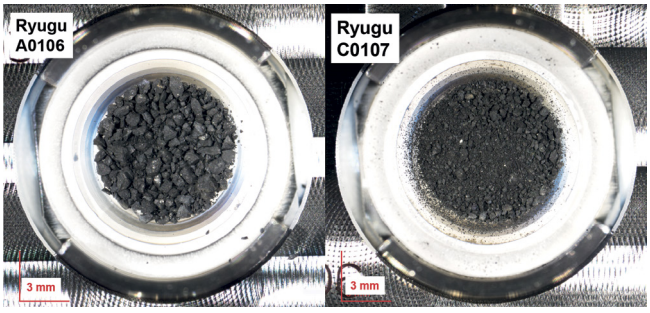
"Scientists have previously found nucleobases and vitamins in certain carbon-rich meteorites, but there was always the question of contamination by exposure to the Earth's environment," Oba explained. "Since the *Hayabusa2* spacecraft collected two samples directly from asteroid Ryugu and delivered them to Earth in sealed capsules, contamination can be ruled out."

The researchers extracted these molecules by soaking the Ryugu particles in hot water, followed by analyses using liquid chromatography coupled with high-resolution mass spectrometry. This revealed the presence of uracil and nicotinic acid, as well as other nitrogen-containing organic compounds.

"We found uracil in the samples in small amounts, in the range of 6–32 parts per billion (ppb), while vitamin B_3 was more abundant, in the range of 49–99 ppb," Oba elaborated. "Other biological molecules were found in the sample as well, including a selection of amino acids, amines and carboxylic acids, which are found in proteins and metabolism, respectively." The compounds detected are similar but not identical to those previously discovered in carbon-rich meteorites.

The team hypothesizes that the difference in concentrations in the two samples, collected from different locations on Ryugu, is likely due to the exposure to the extreme environments of space. They also hypothesized that the nitrogen-containing compounds were, at least in part, formed from the simpler molecules such as ammonia, formaldehyde and hydrogen cyanide. While these were not detected in the Ryugu samples, they are known to be present in cometary ice—and Ryugu could have originated as a comet or another parent body which had been present in low temperature environments.

"The discovery of uracil in the samples from Ryugu lends strength to current theories regarding the source of nucleobases in the early Earth," Oba concludes. "The OSIRIS-REx mission by NASA will be returning samples from asteroid Bennu in September 2023, and a comparative study of the composition of these asteroids will provide further data to build on these theories." ●

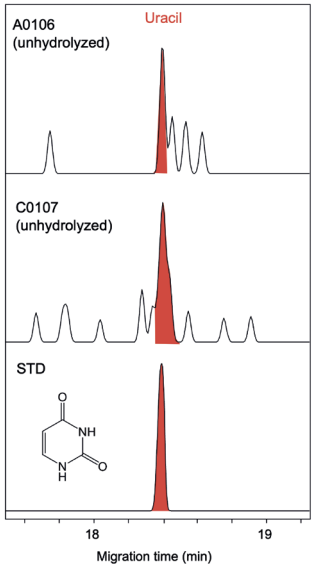


Photographs of samples A0106 and C0107 collected from the asteroid Ryugu, during the 1st touchdown sampling and 2nd touchdown sampling, respectively (Yasuhiro Oba, et al. *Nature Communications*. March 21, 2023).

ORIGINAL ARTICLE
Yasuhiro Oba, et al. Uracil in the carbonaceous asteroid (162173) Ryugu. *Nature Communications*. March 21, 2023.

FUNDING
JSPS KAKENHI (21H04501, 21H05414, 21J00504, 21KK0062, 20H00202); Consortium for *Hayabusa2* Analysis of Organic Solubles by NASA; JAMSTEC, Keio University and HMT Inc.; Hokkaido University (21G008, 22G008).

CONTACT
**Associate Professor Yasuhiro Oba
Institute of Low Temperature Science
Hokkaido University
oba@lowtem.hokudai.ac.jp**



Mass chromatograms from the first (top) and second (center) samples from asteroid Ryugu, showing the presence of uracil (red peak). They were compared to a sample of pure uracil (bottom) (Yasuhiro Oba, et al. *Nature Communications*. March 21, 2023).

Understanding the Impact of CLIMATE CHANGE

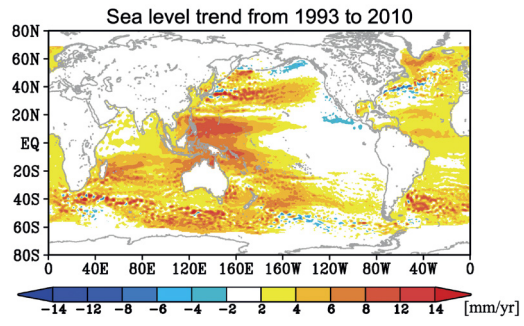
Hokkaido University launched a new website to introduce its researcher's discoveries and their ongoing scientific endeavors in the field of climate change and global warming.

These and more articles, in English and Japanese, are available on the website

TRACKING PROGRESS TOWARDS THE SDGS VIA REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS

Associate Professor Ram Avtar
Faculty of Environmental Earth Sciences

Ram Avtar spoke about how he uses remote sensing and geographic information systems (GIS) to track progress towards achieving the United Nations Sustainable Development Goals (UN SDGs).



MODELING OCEAN TO UNDERSTAND NATURAL PHENOMENA

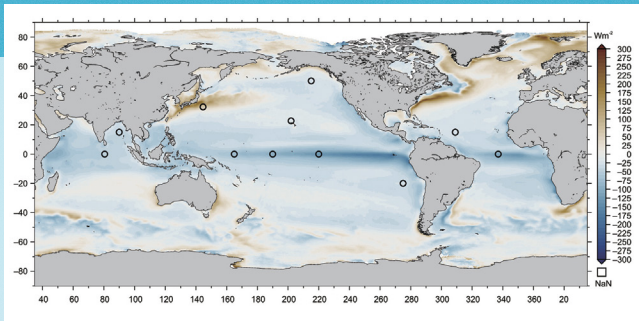
Associate Professor
Yoshi N. Sasaki, Faculty of Science

Yoshi N. Sasaki spoke about what he has learned about the relationship between ocean currents, sea level and climate change, what research he is currently focusing on, and the appeal of research that uses numerical modeling to uncover natural phenomena.

MARINE PLANKTON AND ECOSYSTEMS AFFECTED BY CLIMATE CHANGE

Assistant Professor Kohei Matsuno,
Faculty of Fisheries Sciences

Kohei Matsuno spoke about how climate change is changing the distribution and ecology of marine plankton and what impact this will have on higher-trophic predators, including humans.



EXPLORING CLIMATE CHANGE THROUGH ATMOSPHERE-OCEAN INTERACTIONS

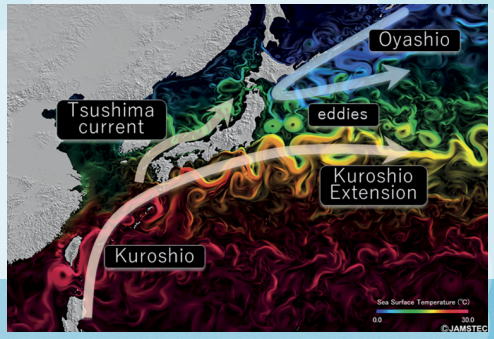
Associate Professor Hiroyuki Tomita, Faculty of Environmental Earth Sciences

Hiroyuki Tomita talks about his research that utilizes satellite observation data to accurately estimate 'air-sea fluxes' and better understand the mechanisms and effects of climate change.

BIG DATA ANALYSIS TO UNDERSTAND ATMOSPHERE-OCEAN INTERACTIONS

Professor Shoshiro Minobe, Faculty of Science

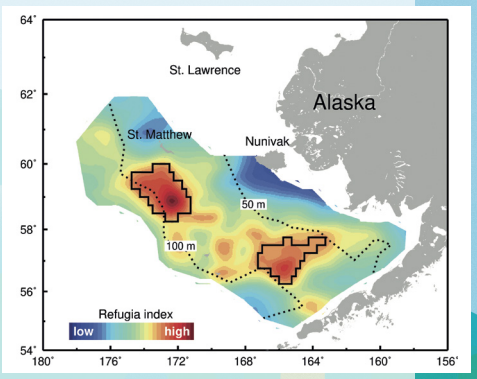
Shoshiro Minobe, who was selected as one of the 1000 most influential climate scientists in the world by Reuters in May 2021, spoke about his research into atmosphere-ocean interactions.



UNDERSTANDING BIODIVERSITY CHANGES IN SUB-ARCTIC AND ARCTIC SEAS FROM SPECIES DISTRIBUTION MODELS

Dr. Irene D. Alabia, Arctic Research Center

Irene Alabia, who uses species distribution modeling to study biodiversity trends in the Arctic seas, spoke about how she uses available species observations and environmental data to predict changes in these waters over short and long timescales.



CLIMATE CHANGE AND DEMOCRATIC INNOVATION

Associate Professor Naoyuki Mikami Institute for the Advancement of Higher Education

Naoyuki Mikami, who approaches climate change from a sociological perspective, points out that tackling global warming requires drastic changes that may not be feasible under the current democratic system.

Cathode active materials for lithium-ion batteries could be produced at low temperatures

Layered lithium cobalt oxide, a key component of lithium-ion batteries, has been synthesized at temperatures as low as 300°C and durations as short as 30 minutes.

Lithium ion batteries (LIB) are the most commonly used type of battery in consumer electronics and electric vehicles. Lithium cobalt oxide ($LiCoO_2$) is the compound used for the cathode in LIB for handheld electronics. Traditionally, the synthesis of this compound requires temperatures over 800°C and takes 10 to 20 hours to complete.

A team of researchers at Hokkaido University and Kobe University, led by Professor Masaki Matsui at Hokkaido University's Faculty of Science, have developed a new method to synthesize lithium cobalt oxide at temperatures as low as 300°C and durations as short as 30 minutes. Their findings were published in the journal *Inorganic Chemistry*.

"Lithium cobalt oxide can typically be synthesized in two forms," Matsui explains. "One form is layered rock-salt structure, called the high-temperature phase, and the other form is spinel-framework structure, called the low-temperature phase. The layered $LiCoO_2$ is used in Li-ion batteries."

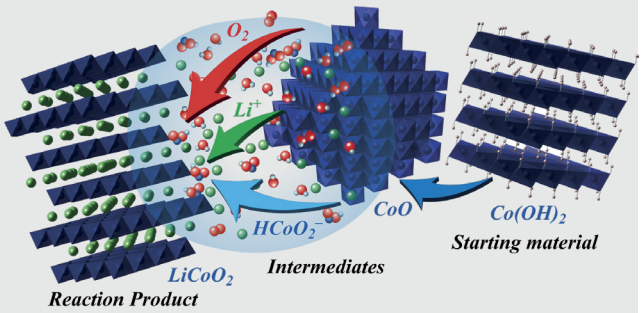
Using cobalt hydroxide and lithium hydroxide as starting materials, with sodium or potassium hydroxide as an additive, the team conducted a series of high-precision experiments under varying conditions to synthesize layered $LiCoO_2$ crystals. The process was called the "hydroflux process". They were also able to determine the reaction pathway that led to the formation of the layered crystals.

"By understanding the reaction pathway, we were able to identify the factors that promoted the crystal growth of layered $LiCoO_2$," Matsui said. "Specifically, the presence of water molecules in the starting materials significantly improved crystallinity of the end product."

The team also measured the electrochemical properties of the layered $LiCoO_2$, showing that they were only marginally inferior to that of commercially available $LiCoO_2$ synthesized by the traditional high temperature method.

"This work is the first experimental demonstration of the thermochemical stability of layered $LiCoO_2$ at low temperatures under ambient pressure," concludes Matsui. "Our development of this hydroflux process will enable energy saving measures in various ceramic production processes. Our immediate next steps will be the improvement of the hydroflux process based on our understanding of the reaction pathway."

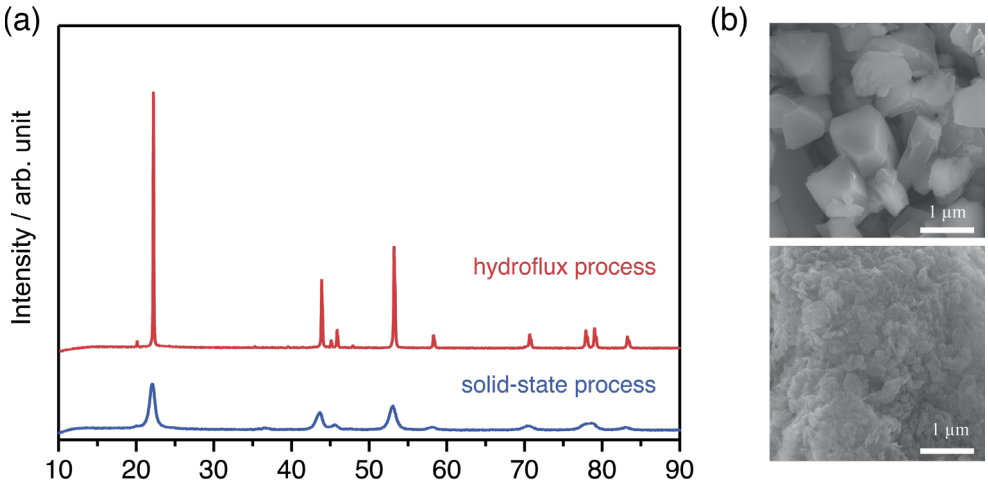
Reaction pathway of the hydroflux process to form layered lithium cobalt oxide ($LiCoO_2$) at 300 °C. Illustration: Masaki Matsui



ORIGINAL ARTICLE
Rannosuke Maeda, et al. Kinetically Enhanced Reaction Pathway to Form Highly Crystalline Layered $LiCoO_2$ at Low Temperatures Below 300 °C. *Inorganic Chemistry*. October 23, 2023.

FUNDING
MEXT KAKENHI (19H05812, 19H05813); JSPS KAKENHI (18K19131).

CONTACT
**Professor Masaki Matsui
Faculty of Science
Hokkaido University
matsui@sci.hokudai.ac.jp**



Obvious crystal growth of $LiCoO_2$ synthesized via hydroflux process compared with solid-state process at 300 °C by (a) XRD and (b) SEM observation. (Rannosuke Maeda, et al. *Inorganic Chemistry*. October 23, 2023)

Marine bacteria take a bite at plastic pollution

A bacterium found in the sea can degrade a plastic that otherwise resists microbial breakdown in marine environments.

A bacterium that can degrade the common polymer polybutylene succinate (PBS), which naturally biodegrades to only a limited extent in marine environments, could lead to improved ways to recycle this polymer. The bacterium's potential, and its enzyme molecule that breaks down PBS, was discovered by researchers at Hokkaido University, working with colleagues at the Mitsubishi Chemical Group in Japan. The team published their results in the journal *Environmental Microbiology*.

PBS is generally regarded as an eco-friendly polymer due to its biodegradability when discarded on land and exposed to the atmosphere. This has led to its increasing use since the early 1990s in industrial plastics, including mulching films, compostable bags and catering packaging. But many discarded plastics eventually find their way into the sea, and unfortunately PBS does not biodegrade well in that environment.

"Plastic pollution in the ocean is a global problem and we need to tackle it by gaining new understanding of plastic behaviour in that environment, and new technologies to deal with the pollution," says Tomoo Sawabe, leader of the research team at Hokkaido University's Faculty of Fisheries Sciences.

As only a small number of marine microorganisms able to biodegrade PBS had been discovered previously, Sawabe and his colleagues set out to try to find others and with better activity.

They examined the effect on PBS of microbes gathered from natural seawater off Japan, allowing them to identify several types of marine bacteria that could degrade it. They also identified the enzyme responsible for degrading PBS in a specific strain of bacteria called *Vibrio ruber*. They named the enzyme PBSase.

They then took things further by using molecular biological techniques to insert the gene for PBSase into the common bacterium *Escherichia coli*, which they cultured to produce highly purified samples of the enzyme for further study.

"Elucidating the degradation mechanism in seawater at the molecular level may lead to the development of new marine biodegradable polymers," says Yasuhito Yamamoto, Sawabe's collaborator at Mitsubishi Chemical Corporation of the Mitsubishi Chemical Group. "This enzyme could be used as a decomposition accelerator or catalyst for chemical recycling of collected waste plastics."

The availability of the purified enzyme also allowed the researchers to examine its structure, with simulations suggesting it was closely related to a different enzyme known to degrade another common polymer: polyethylene terephthalate (PET).

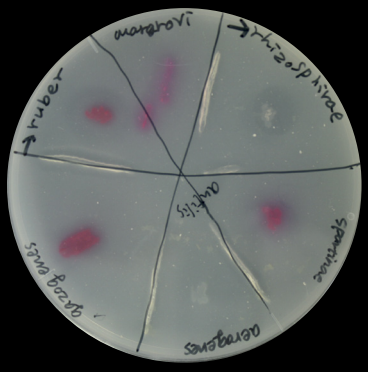
"By exploring the enzyme's activity in degrading other polymers, such as PET, we hope that our work will contribute more widely to advances in plastic recycling technologies," Sawabe concludes.

This research is part of wider efforts to address the complexity of biodegradable polymer technologies caused by their differing biodegradability on land and in the sea. By learning more about what controls biodegradability in different environments, scientists will hopefully develop polymers that are best suited to the environments they are used in, and those that they may end up in after use. ●

ORIGINAL ARTICLE
Yutaro Kimura et al., A lesson from polybutylene succinate plastisphere to the discovery of novel plastic degrading enzyme genes in marine vibrios. *Environmental Microbiology*, September 29, 2023.

FUNDING
Toppan Inc. (PC86180005).

CONTACT
Professor Tomoo Sawabe
Faculty of Fisheries Sciences
Hokkaido University
sawabe@fish.hokudai.ac.jp



Vibrio ruber was shown to degrade PBS. (Yutaro Kimura et al., *Environmental Microbiology*, September 29, 2023)

The protein structure of PBSase. The catalytic centers are indicated by magenta and green. (Yutaro Kimura et al., *Environmental Microbiology*, September 29, 2023)

NEW FACILITIES

The ribbon-cutting ceremony took place in front of the new building's entrance. Photo by Manami Kawamoto

WPI-ICReDD's new building, towards revolutionizing research and sustainability

The new building of Hokkaido University's Institute for Chemical Reaction Design and Discovery (WPI-ICReDD), completed in early 2023, is the newest addition to Hokkaido University's Creative Research Institute building complex, located in the North Campus area.

This new four-story, 5,500 m^2 WPI-ICReDD building, inaugurated on June 16, 2023, is characterized by novel functionalities for revolutionizing research in chemistry. The two-story "Fusion Research Office" brings together researchers of varying backgrounds, thus promoting more interdisciplinary collaborations. The open space and lounge areas offer a comfortable environment, not limited to working, but also for relaxation and casual interactions.

The building has acquired the "Net Zero Energy Building (ZEB) Ready" certification by employing a "passive architectural design." It can withstand the weather of any season with minimal energy consumption.

In the new building, two mix laboratories and a smart laboratory are provided with advanced technology and equipment to support different types of research. Photo: Miho Nagao

(Above) The building of Smart Agriculture Education and Research Center which celebrated its opening. Photo by Manami Kawamoto

(Left) Robot hangar on the first floor. Photo by Miho Nagao

Smart Agriculture Education and Research Center inaugurated

Smart agriculture is a technology that utilizes robotics and information & communication technology (ICT) to stably produce high-quality agricultural products based on data, rather than by relying on human intuition and experience. The *Hokkaido University Smart Agriculture Education and Research Center*, opened on August 31, 2023, will serve as a hub for the realization of education and research as well as its implementation in society in this particular field.

The first floor of the two-story building houses a robot hangar for robot farming machines developed at the University, and facilities for manufacturing and modifying these robots. The second floor is used for the development of data communication and information processing technologies. A robot monitoring room is also located on the second floor. The Center serves as an open laboratory where new technological development is carried out in collaboration with companies.

Historical Building on Sapporo Campus renovated into Hokkaido University Wine Education and Research Center

A beautiful white-and-pale-green building stands amidst the elm trees of Hokkaido University. Built in 1901, once used as an entomology and sericulture classroom—and one of the oldest buildings on the campus—it has now been reborn as the *Hokkaido University Wine Research and Education Center*. Over time, it will serve as a new base for research, promotion, and human resource development of Hokkaido wines.

The conservation and renovation of the building was based on the concept of "preserving the value of cultural assets while ensuring that they will endure for the next 100 years." Opting for an exposed-beam design for the ceiling of the gallery space emphasizing the original beams, and using wood from Hokkaido University's research forests for its ceiling plywood and flooring, the space creates a perfect blend of the past and present of Hokkaido University.

Behind the Center is an intriguing stone building named Insecta Matsumurana. This building was once internationally known for housing one of the best collections of insect specimens in Japan by entomologist Shonen Matsumura; it is now a wine cellar. Inside the cellar, a gorgeous elm tree table lies in the center. There are wine refrigerators on both sides and a beautiful view of the Elm Grove from the windows.

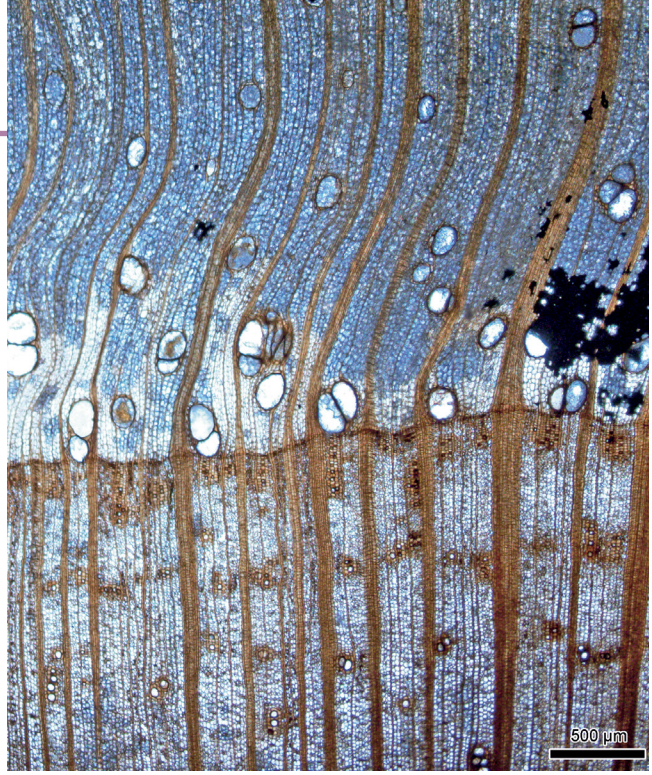
1 **Sun shines on the renovated former entomology and sericulture classroom—now Wine Education and Research Center.** Photo by Ayumi Hasegawa

2 **Named after a scientific journal, the building "Insecta Matsumurana" has been converted into a wine cellar for the research facility.** Photo by Miho Nagao

3 **Inside the wine cellar.** Photo by Miho Nagao

Miocene period fossil forest of *Wataria* found in Japan

An exquisitely preserved fossil forest from Japan provides missing links and helps reconstruct a whole Eurasia plant from the late Miocene epoch.



Wataria parvipora showing annual rings. It is one of the characteristics that helped the scientists in identifying the wood-fossil. (Nishino et al., *Scientific Reports*, June 22, 2023)

Complete plant fossils are seldom found as a single piece, as wood, leaves, flowers, fruits, seeds, or pollen detach easily from plants. This results in leaves and trunks having separate scientific names. Putting together the different parts to reveal the complete plant is like putting together a jigsaw puzzle. Connecting these dots and reconstructing plants is important to establish their taxonomic identity—their place in the Tree of Life.

A research group led by Professor Toshihiro Yamada from the Department of Earth and Planetary Sciences, Hokkaido University, found an exceptionally well-preserved fossil of a *Wataria parvipora* forest which was almost exclusively accompanied by fossils of *Byttneriophyllum* leaves. Their findings were published in the journal *Scientific Reports*.

In 1994, Kiso River (in Minokamo City, Gifu Prefecture) underwent a historic drought, in the process of which 400 in situ fossilized tree stumps surfaced. While most of the stumps have since been submerged, the team examined 137 stumps, of which 130 were identified as *Wataria parvipora*. "*Wataria* is a wood-fossil, recognized by its distinctive growth rings, abundant parenchyma rays and lack of resin canals. In the 2000 m^2 fossil site, these stumps accounted for 95% of the tree remains, indicating that we discovered a forest predominantly of this species," says Yamada.

The team also found that the stumps were exclusively covered by a bed of one specific kind of leaf. *Byttneriophyllum tiliifolium* is a leaf-fossil species belonging to the mallow family (which includes cotton, cacao and durian). Fossils of this leaf were widely distributed throughout Eurasia during the Miocene and Pliocene epochs and the discovery of the *Wataria* fossil forest indicates that *Byttneriophyllum tiliifolium* are the leaves of *Wataria*.

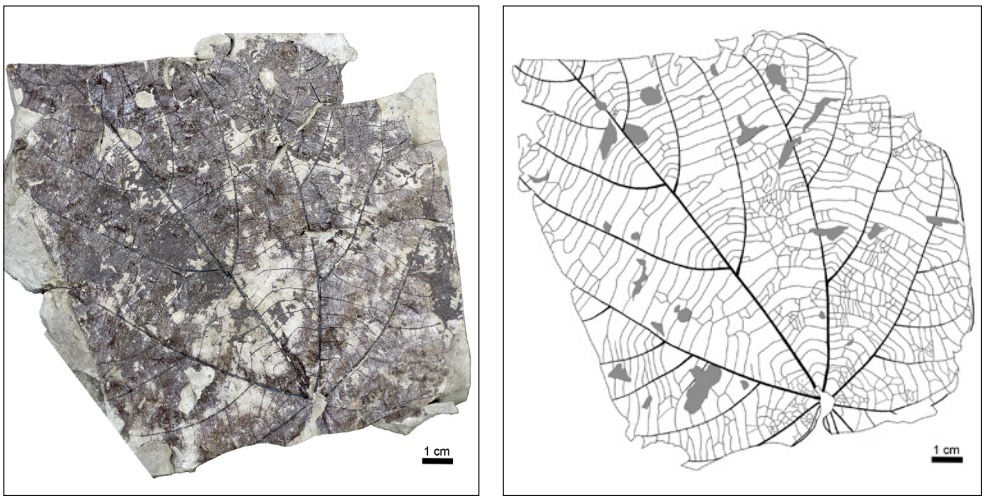
"We found that 98% of the fossil-leaves found at the site belonged to *Byttneriophyllum*, strongly indicating that they were shed from the parent trees. We could see that the leaves were deposited paraautochthonously on the forest floor—they got fossilized where they fell," Yamada elaborated.

Research by other groups has shown that the fossil fruit *Banisteriaecarpum giganteum* is related to *Byttneriophyllum tiliifolium*. Future research will focus on searching for *Banisteriaecarpum giganteum* in Japan, as this discovery would provide strong evidence that all three are part of the same species. ●

ORIGINAL ARTICLE
Nishino Megumi, et al. An exceptionally well-preserved monodominant fossil forest of Wataria from the lower Miocene of Japan. *Scientific Reports*. June 22, 2023.

FUNDING
MEXT (JPMXP0622716984); JSPS KAKENHI (20K22673).

CONTACT
Professor Toshihiro Yamada
Graduate School of Science
Hokkaido University
pbyamada@sci.hokudai.ac.jp



Byttneriophyllum tiliifolium was found abundantly in the fossil forest, indicating a strong link to *Wataria parvipora*. (left) Surface view of the fossil leaf. (right) Line drawing of one of the leaves found. (Nishino et al., *Scientific Reports*, June 22, 2023)

Gas on the run – ALMA spots the shadow of a molecular outflow from a quasar

Theoretical predictions have been confirmed with the discovery of an outflow of molecular gas from a quasar when the universe was less than a billion years old.

A quasar is a compact region powered by a supermassive black hole located in the center of a massive galaxy. They are extremely luminous, with a point-like appearance similar to stars, and are extremely distant from Earth. Owing to their distance and brightness, they provide a peek into conditions of the early universe, when it was less than 1 billion years old.

A team of researchers led by Assistant Professor Dragan Salak at Hokkaido University, Assistant Professor Takuya Hashimoto at the University of Tsukuba, and Professor Akio Inoue at Waseda University, has discovered the first evidence of suppression of star formation driven by an outflow of molecular gas in a quasar-host galaxy in the early universe. Their findings, based on observations they made using the Atacama Large Millimeter/submillimeter Array (ALMA), in Chile, were published in *The Astrophysical Journal*.

Molecular gas is vital to the formation of stars. As the primary fuel of star formation, the ubiquity and high concentrations of molecular gas within a galaxy would lead to a vast number of stars being formed. By ejecting this gas into intergalactic space faster than it could be consumed by star formation, molecular outflows effectively suppress the formation of stars in galaxies that hosted them.

The quasar the researchers observed, J2054-0005, has a very high redshift—it and the Earth are apparently moving away from each other very fast. "J2054-0005 is one of the brightest quasars in the distant universe, so we decided to target this object as an excellent candidate to study powerful outflows," Hashimoto says. The researchers used ALMA to observe the outflow of molecular gas from the quasar. As the only telescope in the world that has the sensitivity and frequency coverage to detect molecular gas outflows in the early universe, ALMA was key to this study.

Speaking about the method used in the study, Salak commented: "The outflowing molecular (OH) gas was discovered in absorption. This means we did not observe microwave radiation coming directly from the OH molecules; instead, we observed the radiation coming from the bright quasar—and absorption means that OH molecules happened to absorb a part of the radiation from the quasar. So, it was like revealing the presence of a gas by seeing the 'shadow' it cast in front of the light source."

The findings from this study are the first strong evidence that powerful molecular gas outflows from quasars exist and impact galaxy evolution at the early cosmic age. "Molecular gas is a very important constituent of quasar-host galaxies because it is the fuel for star formation," Salak concludes. "Our findings show that quasars are capable of suppressing star formation in their host galaxies by ejecting molecular gas into intergalactic space."

Artist's impression of an outflow of molecular gas from the quasar J2054-0005. Credit: ALMA (ESO/NAOJ/NRAO)

A group of ALMA 12-m antennas observing the night sky. Observations in this study were made using the 12-m antennas. Photo: ESO/Y. Beletsky

ORIGINAL ARTICLE
Dragan Salak, et al. Molecular outflow in the reionization-epoch quasar J2054-0005 revealed by OH 119 μm observations. *The Astrophysical Journal*. February, 2023.

FUNDING
NAOJ ALMA Project (NAOJ-ALMA-294, NAOJ-ALMA-2018-09B); MEXT (HJH02007); JSPS KAKENHI (22H01258, 7H06130, 20H01951, 22H0493); NCN SONATA (UMO-2020/39/D/ST9/00720); and JST SPRING (JPMJSP2119).

CONTACT
**Assistant Professor Dragan Salak
Institute for the Advancement of Higher Education
Hokkaido University
dragan@oia.hokudai.ac.jp**

Hokkaido University

Hokkaido University (HU) and The University of Melbourne (UoM) have developed their research-based partnership over years, particularly in the fields of zoonosis control and chemistry. In order to deepen collaborations, HU and UoM have agreed to organize joint conferences to explore new research themes and encourage interdisciplinary research, promote co-supervision of doctoral students, and set up the Hokkaido – Melbourne Joint Research Workshops Fund to support the development of new research collaborations.

&

Indigenous research collaboration getting started between Hokkaido University and the University of Melbourne

Between 22 and 29 June 2023, an indigenous research team from The University of Melbourne (UoM) visited Hokkaido University (HU). The UoM delegation made full use of their eight-day stay in Hokkaido by visiting Nibutani Kotan (Ainu Village) in Biratori, Upopoy the National Ainu Museum and Park in Shiraoi, and the Sapporo Ainu Association, and having interactions with local Ainu people. They shared common issues in Australian and Hokkaido indigenous communities through meetings, two research workshops and a conference: poverty, alcoholism and domestic violences in indigenous households; career paths of indigenous people; ownership of indigenous collections currently stored by national/regional governments or universities; limited accessibility to own roots for those who are born from an indigenous and non-indigenous couple and for indigenous families growing up outside regional indigenous communities. Active discussions included significance and difficulties regarding non-indigenous researchers' involvement in Indigenous Studies, how academic institutions can initiate research projects cooperating with indigenous communities, universities' role in connecting sometimes closed indigenous communities and their potential oversea counterparts, universities as a place for government-community dialogues, co-education in Indigenous Studies, *etc.*

Meeting with Sapporo Ainu Association

Livestock production and physiology researchers gathered in Hokkaido

Between 17 and 22 July 2023, the University of Melbourne (UoM) dispatched its star researchers in Livestock Production and Physiology to a joint workshop with Hokkaido University (HU). The workshop covered a wide range of topics in animal husbandry and livestock production. Due to the quarantine system applied by the Japanese Government, the visitors from Melbourne could not visit any livestock farms in Japan; however, they met Wagyu beef producers Shiraoi and Shimizu during the workshop. Workshop participants also visited HU's Centre for Smart Agricultural Education and Research, Model Barn of the Sapporo Agricultural College, and factories of Megmilk Snow Brand Co., Ltd. and Satsuraku Agricultural Cooperative Association.

Workshop presenters

A visit to Center for Smart Agricultural Education and Research

The University of Melbourne

Delegates of Health Sciences visited Melbourne to promote inter-faculty collaborations

Professor Thompson, Head of the Melbourne School of Health Sciences (left) and Professor Yano, Dean of the Faculty of Health Sciences (right) signing the MoU

Between 4 and 7 September 2023, delegates of Health Sciences, Hokkaido University (HU) paid a visit to a Strategic International Partner of HU, the University of Melbourne (UoM) and met key academics to promote further collaborations on Health Sciences. Recognising increasing demands, a department-level MoU on academic exchange was concluded between the Faculty and Graduate School of Health Sciences, HU and the Faculty of Medicine, Dentistry, and Health Sciences and the Melbourne School of Health Sciences, UoM.

Centre for Digital Transformation of Health

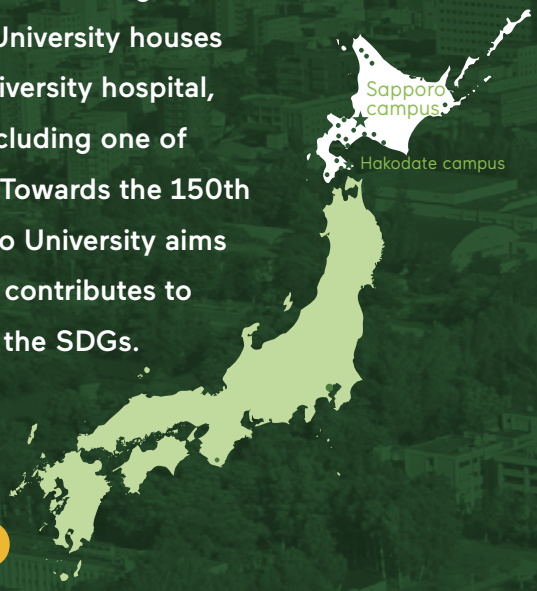
The three-day visit started from the UoM's Centre for Digital Transformation of Health, which conducts various trials for detecting possible failures of digitized health care; Austin Health a major regional medical institution where many UoM academics have their secondment; the Melbourne Brain Centre; classrooms of Nursing, and Optometry and Vision Sciences; and concluded with Professor Daisuke Sawamura's invited seminar at the Department of Optometry and Vision Sciences and Florey Institute of Neuroscience and Mental Health.

Collaborations

Hokkaido University *at a glance*

A Long History

Founded in 1876 as Sapporo Agricultural College, Hokkaido University is one of the oldest, largest, and most prestigious universities in Japan. Boasting one of the largest campuses in Japan, the University houses cutting-edge research facilities, a university hospital, and several field research centers including one of the world's largest research forests. Towards the 150th anniversary of its founding, Hokkaido University aims to be an unparalleled university that contributes to resolving global issues and realizing the SDGs.

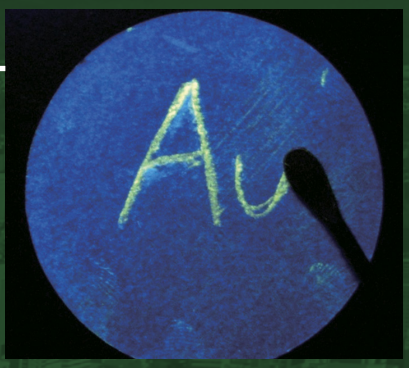


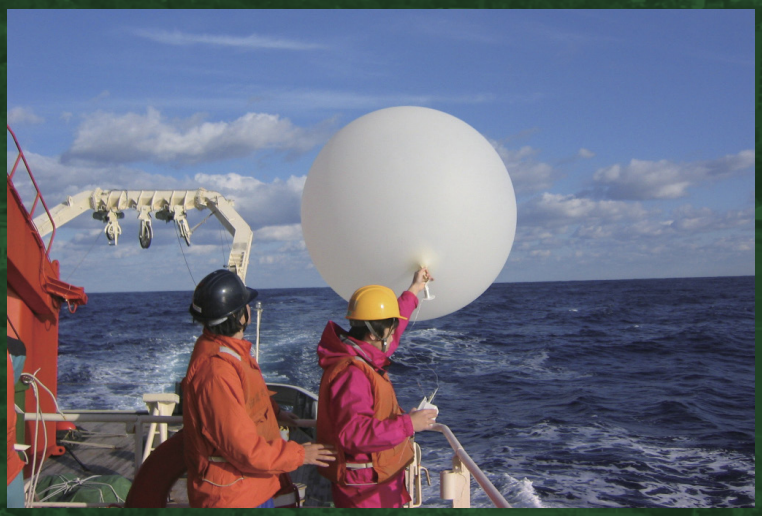
Shining a light
from **Hokkaido**
upon the **world**

Visions for Hokkaido University

The Fourth Period of Mid-Term Goals and Mid-Term Plan, which commenced in 2022, is crucial to the future of the University, and coincides with the 150th anniversary of our founding. The University has developed six visions for this Period, in order to become an autonomous, comprehensive, community-based university. The visions encompass six categories — research, education, collaboration, management, data, and finances — where ambitious measures are being pursued. We are also enacting HU VISION 2030, our medium-term vision leading up to the year 2030. By linking these measures and categories, Hokkaido University will achieve a breakthrough in becoming an unparalleled university.

HU VISION 2030





Research

Since its establishment as an agricultural college, Hokkaido University has expanded its research strengths to encompass a variety of fields in areas such as low temperature science, life sciences, chemistry, veterinary sciences, and fisheries sciences.

The Global Institution for Collaborative Research and Education (GI-CoRE), established in 2014 to conduct top-level research in strategic areas, has proven exceptionally successful. It now encompasses a total of seven hubs, in fields ranging from Arctic Research to Zoonoses. The Institute for Chemical Reaction Design and Discovery (ICReDD), launched in 2018 as part of the World Premier Research Initiative (WPI) by the Japanese Government, has grown by leaps and bounds, and is now recognized as a pioneer in chemical reaction design.

In 2022, Hokkaido University Professor Benjamin List won the Nobel Prize in Chemistry. He is the second Nobel Laureate affiliated with Hokkaido University, following Hokkaido University Professor Akira Suzuki, a 2010 laureate of the Nobel Prize in Chemistry.

International programs

In addition to the 12 undergraduate and 21 graduate schools, Hokkaido University runs a number of degree programs taught in English for international students. The Modern Japanese Studies Program and (MJSP) and the Integrated Science Program (ISP) are for undergraduate students; at the graduate level, there are eight specialized programs, and many graduate schools also offer courses in English.

During the summer, the Hokkaido Summer Institute (HSI) offers over 340 short programs in English covering a wide range of disciplines. The courses are run by top-level researchers from the University and around the world. A plurality of the HSI courses is now offered in a hybrid format, allowing a much more diverse group of students to enroll.

International Student Guide

Hokkaido Summer Institute

TODAY
Data as of May 2023

1876
established

660km²
total area of campuses and facilities

12
undergraduate schools

21
graduate schools

242,319
alumni

748***
partner institutions
***Located in 73 countries/regions

18,057*
students
*Including 2,177 international students from 98 countries/regions

3,920**
faculty & staff
**Including 875 International Staff

RANKING

22nd
in the world
Times Higher Education World University Impact Rankings 2023

7th
in Japan
Times Higher Education Japan University Rankings 2023

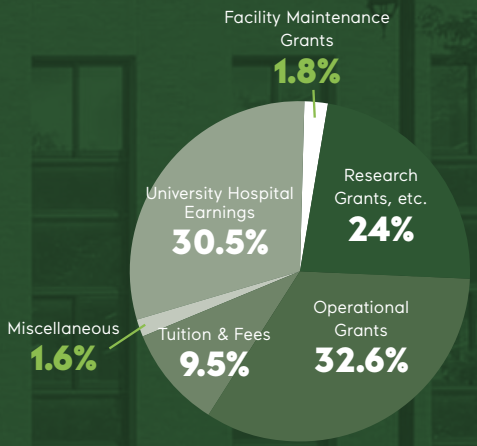
32nd
in Asia
QS World University Rankings: Asia 2024

6-8th
in Japan
2023 Academic Ranking of World Universities

5th in Japan **113th** in the world
Nature Index: Institutional Tables (August 1, 2022 – July 31, 2023)

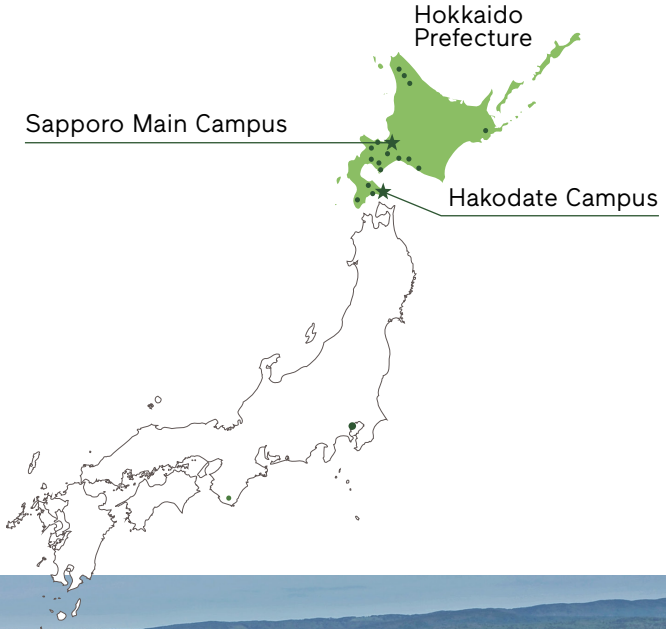
REVENUE

¥110,860m
revenue in 2023



HOKKAIDO UNIVERSITY

Founded in 1876 as Sapporo Agricultural College, Hokkaido University is one of the oldest, largest, and most prestigious universities in Japan. The university attracts prospective students from all around the globe with the diverse degree programs offered and the year-round scenic beauty. The campuses are located in the cities of Sapporo and Hakodate of Hokkaido, and 21 facilities are spread throughout Hokkaido and mainland Japan.



Contact
Public Relations & Communications Division
Office of Public Relations and Social Collaboration
Hokkaido University
Kita 8, Nishi 5, Kita-ku, Sapporo
Hokkaido, Japan 060-0808
prc@ops.hokudai.ac.jp