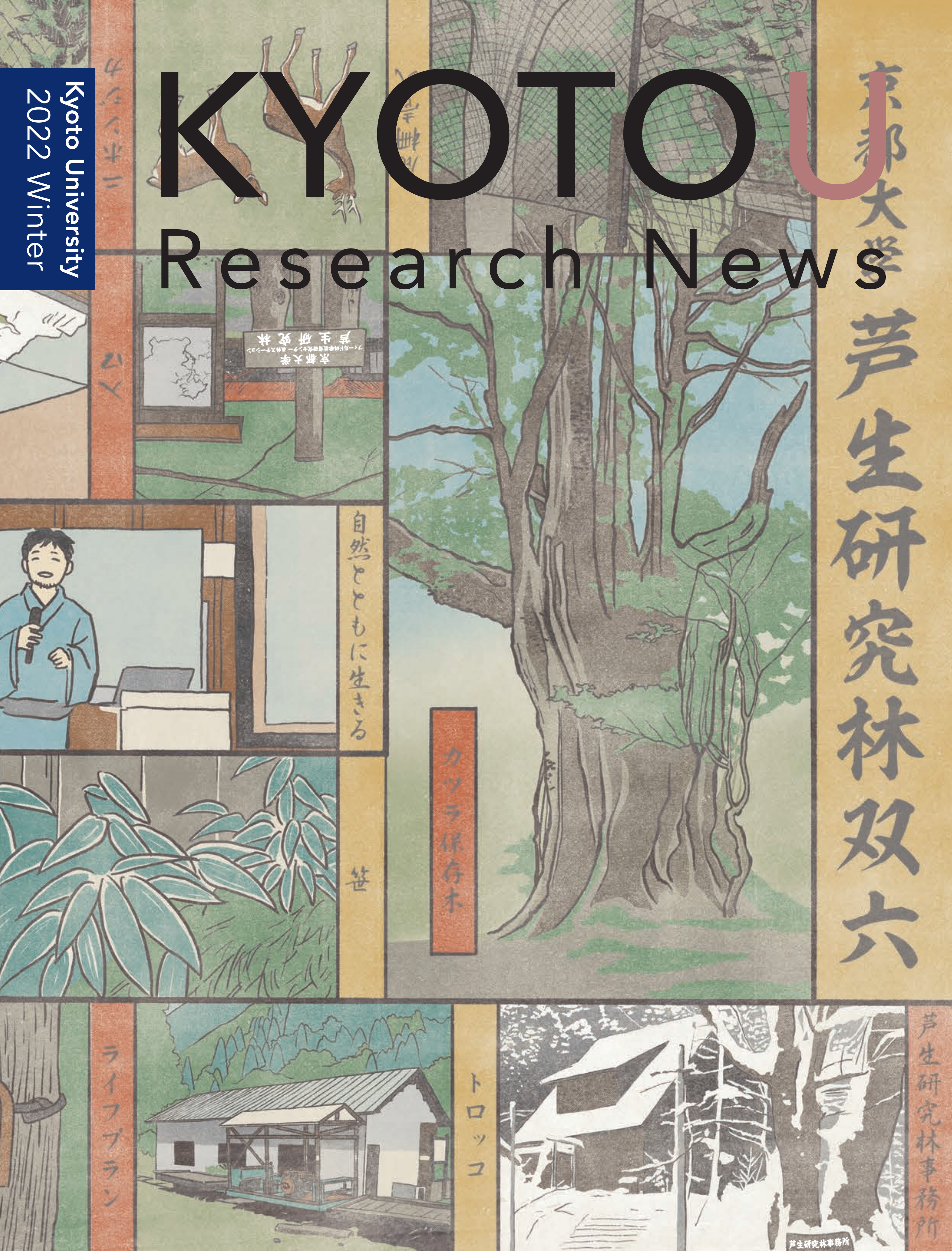
KYOTO U Research News

Kyoto University 2022 Winter



Celebrating the 125th anniversary

Founded in 1897, Kyoto University welcomes you to join us in marking an important milestone in 2022: our 125th anniversary.

The University has matured considerably since its early days. It has always been the second largest national university in Japan, but over the decades it has steadily grown and garnered international accolades making it one of the top-ranked educational and research institutions in the world. A special website has been established for this occasion, including alumni profiles and reflections, University history, and anniversary events, with more being added constantly. We encourage you to pay us a visit and explore what makes KyotoU such a unique university in Japan and the world.

We have also established a special 125th fund. We ask your generosity in considering a donation to help our efforts to continue pursuing the highest possible standards in scholarship and teaching as we press forward into the future.

Please see: **125th.kyoto-u.ac.jp/en**

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PUBLICATION NOTICE

With this issue, KyotoU Research News will enter a hiatus. Please see our website for the latest research developments while we consider the best ways to bring you news from Kyoto University.

Thank you for reading and we hope you've enjoyed our magazine!

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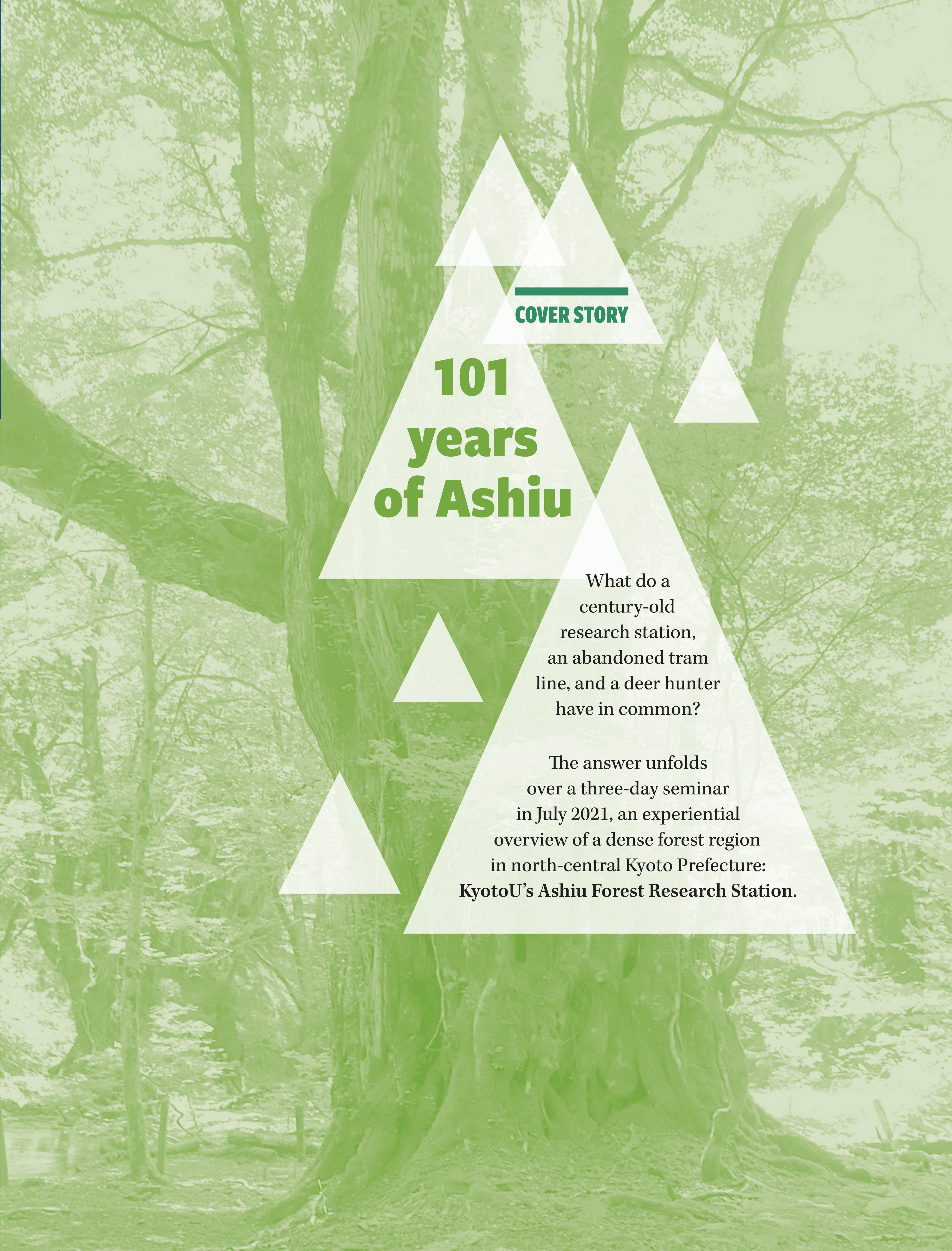


COVER STORY

101 years of Ashiu

What do a century-old research station, an abandoned tram line, and a deer hunter have in common?

The answer unfolds over a three-day seminar in July 2021, an experiential overview of a dense forest region in north-central Kyoto Prefecture: **KyotoU's Ashiu Forest Research Station.**

The nearly-pristine and ecologically diverse biome occupies nearly 4.2 kilohectares and receives substantially more precipitation, including snowfall, than the city of Kyoto to its south. Tall conifers, mainly cedar, and broad-leaved deciduous trees — typically beech and oak — seem to line every path and envelop every clearing and meadow.

Yet all is not exactly green and gleeful in this temperate forest paradise.

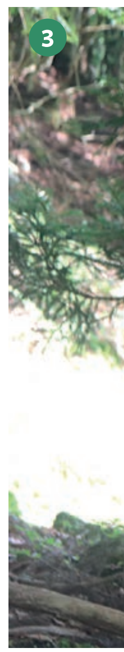
Since its establishment in 1921 for research and training, certain forest patches continued to be harvested for lumber and other uses as a source of income for the university. Today the forest is preserved and studied by the University while serving as a resource for conservation-minded locals.

Given that some species have 'Ashiu' in their names — and new ones continue to be discovered even today — it is easy to appreciate how special the forest is and has been for the past 101 years.

Day 1: "Enter the data"

The summer seminar begins with an introduction to LIFEPLAN, an international program spearheaded by the University of Helsinki, which takes a novel and multifaceted approach to collecting and analyzing biodiversity big data, using digital

Ashiu is part of a global network of 100 sampling sites



ONE CENTURY IS BUT A BLINK FOR THE FOREST

Ashiu Forest Research Station is nestled in a series of densely forested hills and valleys in Miyama, in what is designated as the Kyoto Tamba Kogen Quasi-National Park.

Beneath its quiet appearance, however, the forest has a remarkable centuries-long history, becoming a logging domain that flourished from the Meiji to the Taisho period, from the latter quarter of the 19th Century to the early decades of the 20th. Japanese beech and cedar, and other naturally grown trees were harvested, from which locals produced handicrafts and charcoal.

After AFRS was established in 1921, logging and charcoal production continued until the late 1980s. Tramways introduced during the period of lumber harvesting and charcoal production dramatically improved transportation efficiency.

While some original timber stands have been converted to artificial forests, today half of the entire area has been kept intact for over a century, including some old-growth groves that date back many hundreds of years at least.

AFRS chief scientist Masae Ishihara and team are continuing efforts to restore the forest by fencing off vulnerable areas and working with local residents, guides, and experts in other fields such as hunting, economics, and art.

In marking its 100th anniversary in 2021, AFRS is promoting the forest's relevance and importance through fundraising efforts with the slogan: *For the forest where diverse creatures live; For a place where diverse people learn together.*

Speaking of the changes over the past century Ishihara remarks, "We need everyone's cooperation and collaboration to ensure the preservation of the forest for future generations."

❶ Research station main building
❷ Following the old tramway into the forest
❸ Chief scientist Ishihara explaining the LIFEPLAN camera

technologies, AI, and DNA analysis. Ashiu is part of a global network of 100 sampling sites, working together over a six-year period beginning in 2020.

Participants learn how sample data of fungal spores captured from the air, recorded bird songs, trapped insects, and images of larger wildlife caught on automated cameras are sent to LIFEPLAN's headquarters in Sweden for analysis, where they are combined with readings from across the globe.

forensic ecologists have identified the culprits: wild deer

Day 2: "Enter the... deer"

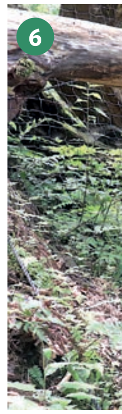
The focus of the second day of the seminar is the current state of the forest's health. Before-and-after photographs present startling evidence that the once rich, verdant undergrowth has given way to sickly patches of bare ground.

Anyone with trained observational skills would be able to deduce the prime cause of the disappearing native vegetation: deer.

The grasses and flowers that constituted the undergrowth in the past have been grazed to oblivion by *sika* deer — *nihon-jika* — over the course of decades. In places, the forest floor turned a barren brown by the end of the first decade in this century.

The only plants that have survived are *Veratrum oxyseum*, *Pterostyrax hispidus*, *Hypolepis punctata*, *Dennstaedtia zeylanica*, and several other species which the deer appear to find unpalatable.

Persistent overgrazing consumes and reduces seeds in the ground, further



BEHIND GREAT RESEARCH ARE GREAT TECHNICIANS

An architect with a vision and blueprints can claim credit for constructing a building, but carpenters still need to nail the beams together, electricians wire the power, and plumbers pipe in the water.

Ashiu's natural beauty can be viewed as a house of technicians working together to solve problems and keep the preserve operating smoothly, facilitating and carrying out the work of KyotoU's researchers. These technical staff hail from different parts of Japan and diverse backgrounds, some with specialized expertise and others with little prior work in forest conservation.

"They are our unsung heroes," says professor Naoko Tokuchi of KyotoU's Field Science Education and Research Center, praising her 38 technical staff members stationed at ten different locations throughout Japan, including eight now at Ashiu Forest Research Station.

These staff members are tasked with handling a kaleidoscope of duties including: monitoring climate, stream water chemicals, forest growth, and environmental DNA; clearing access routes after several meters of snowfall; fixing fences to protect native plants from the insatiable appetites of wild deer; supporting young researchers and students as they face unpredictable conditions in nature; and educating students and visitors about conservation efforts.

Tokuchi especially values her technicians' indispensable roles in bridging the gap between the researchers and the general public, particularly when doing outreach to school children and prospective research students. After all, a strong house is built with the future in mind.

❹ Studying the topography of Ashiu
❺ Ishihara explaining about *kuma-hagi* (bear damage)
❻ A technician explaining about deer netting
❼ Deer nets encircling a valley
❽ Observing abundant native plant regrowth inside a netted area
❾ An old growth specimen greeting visitors

preventing the recovery of plant cover and reducing biodiversity.

As part of a wider operation combining research and conservation, the forest station staff, together with researchers, students, citizen scientists, local governments, and volunteers, installed and maintain tall fences, encircling areas as large as two forested watersheds, to protect enclaves of endangered undergrowth. Two such fences currently stand 1.8 km in length and another at 1.5 km.

Furthermore, small fences are maintained to protect grassland and wetland, while some plants difficult to protect by fences are grown separately at KyotoU and the Kyoto Botanical Gardens.

This strategy has been largely successful, as it has led to sustained regrowth of many native plants, although the deer have proven to be a particular challenge in this regard. Where there is a will…

Then there are the bears.

Regardless of food availability in the forests, the omnivorous Asiatic black bear occasionally strips conifers' bark and chews on their soft inner fibers. The stripped sections then tend to rot, eroding into cavities of fungi.

While this damage — called *kuma-hagi* — is arrestingly visible in the short term, the long term extent and severity of damage caused by overgrazing deer are far greater: potentially irreversible.

Sometimes progress is only seen after repeatedly taking several steps backward for each step forward, but as long as it is not a total retreat, there is hope for the future of the forest. The large, symbolic *katsura* tree — *Cercidiphyllum japonicum* — standing in the midst of the wood symbolizes that hope for a harmonious and sustainable future.

Day 3: "Enter the hunter"

The seminar concludes with a presentation by a local hunter and farmer who also embodies this vision. What lessons does this local conservationist of the forest have for us?

⑩ Exploring the forest on multiple levels
⑪ One of many examples of forest wildlife
⑫ Participants conclude their Ashiu investigations

hope for a harmonious and sustainable future

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DAY 3 CONTINUES
LIVING TOGETHER WITH THE FOREST

Homare Fujiwara felt he had a calling.

With little on his back and in his wallet, Fujiwara first arrived in Miyama in north-central Kyoto Prefecture at the age of 22. While the rest of his university classmates remained in the city searching for dream jobs amidst the bubble economy of the late 1980s, Fujiwara instead headed into the woods.

There he spent his first seven years learning carpentry and other skills and trades, including hunting and working as a river guide. After purchasing some land, he started his own business with his wife offering outdoor recreation, lodging, hunting, farming, public speaking, and educational services related to conservation and forest sustainability.

This led Fujiwara to collaboration with the University to help control the deer population in the research forest. Fujiwara appears very confident and fulfilled in his role as a conservationist, regularly giving presentations to research students and the general public about his role at Ashiu.

He hopes to continue showing visitors that the life he and his hunting-farming family lead in the forests of Miyama is not only possible but both enjoyable and sustainable.

For more details on Ashiu Research Forest Station and KyotoU's work there, see: *fserc.kyoto-u.ac.jp/wp/blog/archives/945*

Icarus can fly high and save on wax to

"Don't fly too close to the sun," Daedalus warned Icarus. Flying too high would melt the wax in his wings, while going too low would cause the sea's moisture to create drag.

Commercial flight crews do not usually appear in Greek mythology, but they have to work with the occupational hazard of aviation radiation exposure.

Aviation guidelines aim to mitigate the effects of radiation, mainly caused by galactic cosmic rays and *solar energetic particles*, or SEP. The fluxes in the former are stable and predictable: dose rates are no higher than 10 μSv/h at the normal flight altitude of 12 km.

But in the case of SEP, does the frequency of detected solar flares justify the costs of countermeasures? Current mitigation procedures instruct planes to lower altitude or change or cancel flight paths altogether, significantly raising expenses.

A research team led by Kyoto University's Yosuke Yamashiki set out to answer this question by assessing eight flight routes during five *ground level enhancements*, or GLEs: unpredicted radiation spikes recorded by ground-based detectors.

"During a large solar particle event we see sudden SEP fluxes with dose rates exceeding 2 mSv/h," says Yamashiki, "but these are rare and short-lived."

Writing in the journal *Scientific Reports*, the researchers estimate that the maximum flight route dose and dose rate arising from major GLE events would need to exceed 1.0 mSv and 80 μSv/h, respectively, for countermeasures to be deemed necessary.

However, they estimated that dose rates exceed 80 μSv/h only once every 17 years, and route doses over 1.0 mSv occur once in 47 years — longer than flight crews' careers.

So do the risks justify the costs?

"There is no denying the potentially debilitating effects of radiation exposure," admits Yamashiki, "but the data suggest that current measures may be over-compensating for the actual risks." ▲

Quantum physics helps destroy cancer cells

Cancer cell death is triggered within three days when X-rays are shone onto tumor tissue containing iodine-carrying nanoparticles. The iodine releases electrons that break the tumor's DNA, leading to cell death. The findings, by scientists at Kyoto University's Institute for Integrated Cell-Material Sciences (iCeMS) and colleagues in Japan and the United States, were published in the journal *Scientific Reports*.

"Exposing a metal to light leads to the release of electrons, a phenomenon called the photoelectric effect. Albert Einstein's explanation of this phenomenon in 1905 heralded the birth of quantum physics," says iCeMS molecular biologist Fuyuhiko Tamanoi, who led the study.

"Our research suggests it is possible to reproduce this effect inside cancer cells."

A long-standing problem with cancer radiation therapy is that it is not effective at the center of tumors where oxygen levels are low due to the lack of blood vessels penetrating deeply into the tissue. X-ray irradiation needs oxygen to generate DNA-damaging reactive oxygen when the rays hit molecules inside the cell.

Tamanoi, together with Kotaro Matsumoto and colleagues, has been trying to overcome this by finding ways to damage cancer DNA more directly. In earlier work, they showed that gadolinium-loaded nanoparticles could kill cancer cells when irradiated with 50.25 kiloelectron volts of synchrotron-generated X-rays.

In the current study, they designed porous, iodine-carrying organosilica nanoparticles. Iodine is cheaper than gadolinium and releases electrons at lower energy levels.

The researchers dispersed their nanoparticles throughout tumor

Space: the wooden frontier

Humans have relied on forests and trees for shelter, food, and fuel from the earliest times. As technology has advanced, timber has been utilized for buildings, ships, and railroads. And now we may be on the verge of taking wood into space.

Why wood? Building in space with futuristic, 'space-age' materials might seem to be the obvious choice; lumber's fragility and combustibility might seem counter-intuitive by comparison.

Therein lies the rationale for wood: as a natural, economical, carbon-based material, its production is considerably more sustainable than advanced alternatives, and its disposal — especially when dropped from orbit into the upper atmosphere — is complete and without harmful byproducts.

Moreover, earlier investigations in earth-bound labs have demonstrated wood's surprising ability to withstand a wide range of temperatures, from -150 to 150 degrees Celsius. Simulated near-vacuum conditions also resulted in negligible structural deterioration of the wood.

But the next step is to go beyond: to actually take wood into space.

"Wood's ability to withstand simulated low earth orbit (LEO) conditions astounded us," explains Koji Murata, head of the space-wood research effort, and member of the Biomaterials Design Lab at Kyoto University's graduate school of agriculture.

"We now want to accurately estimate the effects of the harsh LEO environment on organic materials."

To accomplish this, Murata's team, including partners Sumitomo Forestry and Japanese space agency JAXA, plans to send a selection of wooden samples from various plant species to the exposed experiment platform of the Kibo module on the International Space Station.

A frame holding the samples will be ferried to the station in early 2022 and then returned to earth for detailed analysis six months later.

"We particularly want to measure the degree of erosion resulting from atomic oxygen collisions with the fibrous material," continues Murata, referring to the fact that LEO is characterized by free oxygen atoms traveling at high velocity, which over time can damage exposed surfaces.

"We also want to see the effects of cosmic rays and the vacuum of space on the mechanical properties of wood."

The results of the experiment are anticipated to provide

clues for developing technology to protect wooden materials exposed in LEO, as part of a larger KyotoU effort dubbed "LignoStella" to launch a wooden satellite — "LignoSat" — in coming years. ▲

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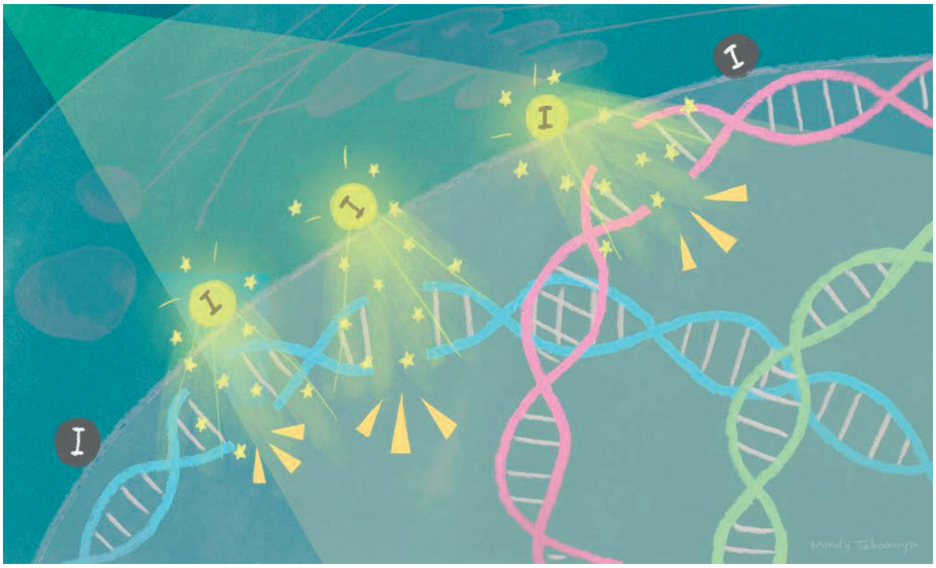
spheroids, 3D tissue containing multiple cancer cells. Irradiating the spheroids for 30 minutes with 33.2 keV of X-rays led to their complete destruction within three days. By systematically changing energy levels, they were able to demonstrate that the optimum effect of tumor destruction occurs with 33.2 keV X-rays.

Further analyses showed that the nanoparticles were taken up by the tumor cells, localizing just outside their nuclei. Shining just the right amount of X-ray energy onto the tissue prompted iodine to release electrons, which then caused double-strand breaks in the nuclear DNA, triggering cell death.

"Our study represents an important example of employing a quantum physics phenomenon inside a cancer cell," says Matsumoto. "It appears that a cloud of low-energy electrons is generated close to its DNA, causing double strand breaks that are difficult to repair, eventually leading to programmed cell death."



The team next wants to understand how electrons are released from iodine atoms when they are exposed to X-rays. They are also working on placing iodine on DNA rather than near it, to increase efficacy, and on testing the nanoparticles on mouse models of cancer.. ▲

Setting Covid-19 drug trials up for success

As scientists continue to search high and low for effective Covid-19 treatments, a new modeling study suggests that randomization, early patient enrollment, and treatment initiation in clinical trials could be the keys to identifying effective antiviral drugs.

Led by Shingo Iwami of Kyoto University's Institute for the Advanced Study of Human Biology (ASHBi) and Keisuke Ejima of Indiana University Bloomington, the researchers reported their findings in *PLOS Medicine*.

"Almost all antiviral clinical trials have failed to observe a significant effect against SARS-CoV-2, so we wanted to show why, and what is important for an optimal study design," explains first author Shoya Iwanami of Nagoya University.

Given the inconsistent results of past trials, Iwanami and colleagues used a mathematical model to first analyze longitudinal patient data from clinical studies. By simulating the amount of virus in patients' upper respiratory tracts, the team found that virus-producing cells died at different rates, classifying patients into those with rapid, medium, or slow virus decay.

Observational studies may have been limited to more severe patients associated with slow decay, failing to capture the spectrum of viral dynamics and confounding the results. In such studies, physicians assess whether and when patients should receive antiviral treatment based on their symptoms, as opposed to randomization where patients are randomly assigned to treatment and control groups. "We found that for successful clinical trials, randomization is important, because differences in virus decay rates can affect the effects of antivirals," explains Iwanami.

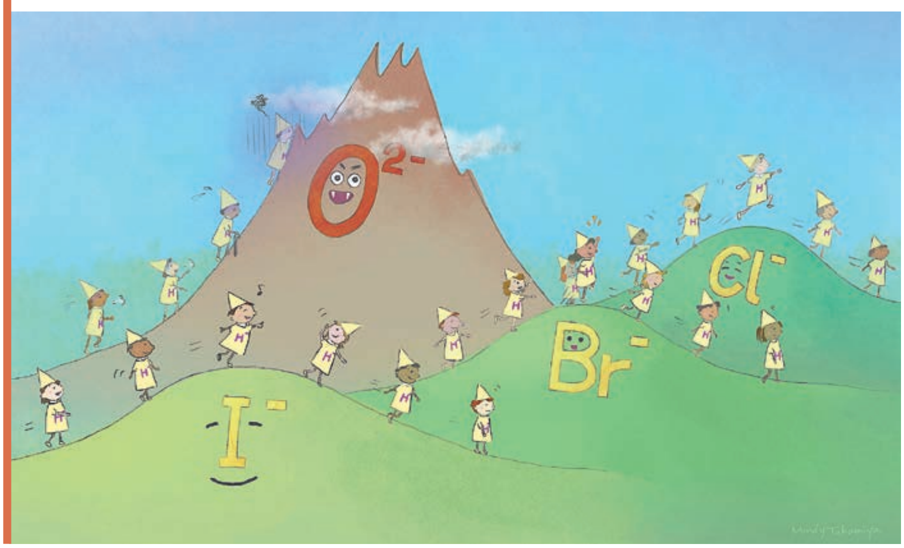
In addition to randomization, timing could also impact the efficacy of potential drug candidates. Regardless of virus decay speed, the researchers' simulations showed that antiviral treatment five days after symptom onset was too late to distinguish drug efficacy, while treatment within the first day of symptom onset improved outcomes across the board.

To mimic randomized controlled trials — the gold standard for evaluating interventions — the researchers added hypothetical drugs with high SARS-CoV-2 inhibition rates

Bringing order to hydrogen energy devices

Researchers at Kyoto University's Institute for Cell-Material Sciences, iCeMS, have developed a new approach to accelerating hydrogen atoms moving through a crystal lattice structure at low temperatures. They report their findings in the journal *Science Advances*.

"Improving hydrogen transport in solids could lead to more sustainable sources of energy," suggests Hiroshi Kageyama of iCeMS, who led the study.



Negatively charged hydrogen *anions* can move very quickly through a solid *hydride* material, consisting of hydrogen atoms attached to other chemical elements. This system is a promising contender for clean energy use, but until now such fast transport has only been observed at high temperatures — above 450° C.

The Kageyama team's breakthrough makes hydrogen anions travel even faster through a hydride at much lower temperatures. "In the past, it was believed that the key to high ionic conductivity at low temperature was to stabilize a material's high temperature phase by introducing chemical disorder," explains Kageyama.

Scientists do this by adding oxygen-containing compounds called oxides into its structure. Instead, Kageyama and his colleagues introduced an ordered structure into a barium hydride crystal, which caused hydrogen anions to move significantly faster even at 200° C. "Achieving high ionic conductivity at lower temperatures by ordering the into their model. As patients in past studies were often recruited without considering treatment timing, the team's model revealed that these clinical trials would have needed to enroll over 10,000 participants per group to provide statistically significant data on drug efficacy — practically impossible in terms of patient recruitment and resource availability.

By contrast, if patients are recruited early and treated within a day of symptom onset, the team found that the required sample size would drop to just 584 participants per group for an antiviral with 95 percent inhibition, and 458 per group for 99 percent inhibition. Ultimately, their findings highlight the importance of randomization as well as of prompt patient recruitment and treatment initiation in evaluating Covid-19 drug candidates. "We can apply this process to other clinical trials or diseases. This model can accelerate drug repositioning and new drug development," proposes Iwanami, adding that trials following their recommendations are already underway. ▲

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anions is unprecedented and may be applicable to various ionic conductors in the future," adds Kageyama.

The scientists changed the structure of a typical barium hydride by introducing layers on either side that are composed of hydrogen attached to another anion. By doing this, they made three different materials, using bromide, chloride, or iodide anions. This provided a more ordered structure to the original material, preventing it from changing from the highly stable and symmetrical hexagon-shaped lattice usually found at high temperatures, to a less stable orthorhombic-shaped structure as it cooled.

Hydrogen anions moved through the organized lattice very quickly at 200°C. The material even conducted the hydrogen anions at room temperature, albeit at a slower rate.

"Improving hydrogen anion conductivity down to room temperatures could enable low-temperature operation of electrochemical devices, like fuel cells, and open up avenues for their use as industrial catalysts or as solid hydrogen sources for hydrogenation reactions," Kageyama predicts. ▲

Life is but a dream

When an important document lands on your desk, you might file it away for safekeeping. The same thing happens with our memories: they first appear in one part of the brain and then move to another for long-term storage in a process known as memory consolidation.

Publishing in the journal *Science*, Kyoto University's Akihiro Goto uses mouse brains to demonstrate a new neural-optic system to manipulate memories. The technique hinders nerve activity — known as *long-term potentiation* or *LTP* — which would otherwise consolidate memory during sleep.

LTP strengthens synapses through neural activity and is critical for memory formation. When and where memories are formed in the brain can be determined by examining when and which cells undergo LTP. Drugs can disrupt LTP, but they have a general effect and are not good at targeting specific brain regions at specific time points in memory consolidation.

Looking for inspiration, Goto turned to Hollywood. "In *Men in Black* the agents erase memories with a light flash. We did something similar," he beams. His team uses light to deactivate proteins essential for LTP.

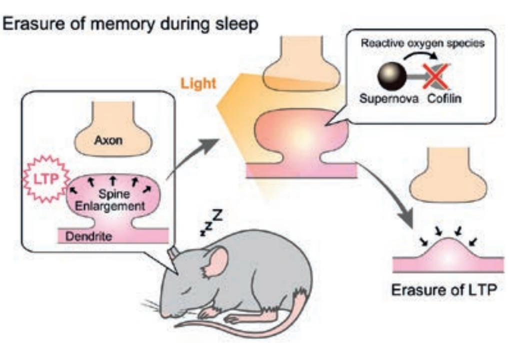
Exchanging black suits and shades for white lab coats and safety goggles, co-author Yasunori Hayashi's team illuminates mouse brains to inhibit *cofilin*, a protein essential for synapses to function.

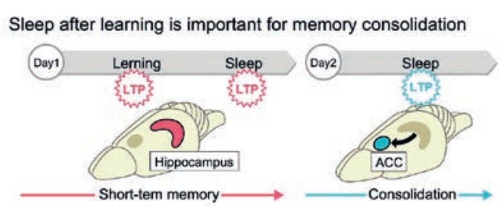
Initially, mouse brains are injected with an *adeno-associated virus* or AAV, commonly used for gene delivery, which then expresses a fused protein made from cofilin and fluorescent SuperNova. When exposed to light, these proteins release reactive oxygen that deactivates nearby compounds like cofilin.

The occurrence of LTP in the hippocampus, where memories are first stored, is significant. When this area of the brain is irradiated, once immediately after the mouse learns a task and then again during sleep after learning, the memory is lost. "It was surprising that eliminating local LTP by targeted illumination clearly erased memory," Goto comments.

Hayashi believes that this new technology provides a method for isolating memory formation both temporally and spatially in the brain at the cellular level.

Synaptic abnormalities related to LTP are involved in memory and learning disorders like Alzheimer's disease and also in psychiatric disorders like schizophrenia. Hayashi concludes, "We expect our method will lead to a range of treatments for mental disorders." ▲





Society is not ready to make human brains

Stem cell research has allowed medicine to go places that were once science fiction. Using stem cells, scientists have manufactured heart, brain, and other cell types that are now being transplanted into patients as part of cell therapy. Eventually, the field anticipates the same will be possible with entire organs.

A new paper written by an international group of researchers led by Tsutomu Sawai, at ASHBi and also the Center for iPS Cell Research and Application, CiRA, explains the future ethical implications of this research with regard to *brain organoids*, laboratory-made structures that are designed to grow and behave like the human brain.

Organoids imitate the ways organs form in the body, making them invaluable tools for understanding not only how organs grow, but also how diseases develop. Organoids have been developed to mimic the liver, kidney, and most controversially, the brain.

The brain is considered the source of our consciousness. Therefore, if brain organoids do truly imitate the brain, they too should develop a form of consciousness, which would incur moral implications. Brain organoids have led to deep questions about consciousness. As some people imagine a future where our 'selves' are uploaded and kept on the cloud well after our bodies die, organoids pose opportunities to test consciousness and morality in artificial environments. "Consciousness is a very difficult property to define. We do not have very good experimental techniques that confirm consciousness. But even if we cannot prove consciousness, we should set guidelines, because scientific advances require them," propounds Sawai, who has spent several years writing about the ethics of brain organoid research.

Ethicists divide consciousness into many types. *Phenomenal consciousness* refers to the awareness of pain, pleasure, and distress. Sawai and his colleagues argue that even though restraints on using brain organoids would be needed, their phenomenal consciousness would not prohibit experimentation outright, since scientific experiments already use animals such as rodents and monkeys that display phenomenal consciousness. If organoids could acquire *self-consciousness,* that higher moral status could raise ethical concerns.

However, Sawai points to a more pressing issue: "One of the biggest problems is transplants. Should we put brain organoids into animals to observe how the brain behaves?" Stem cell research has made the growing of *xeno-organs* possible, turning animals into organ farms that can be harvested for use in human transplantation. While growing whole human brains inside animals is not under any serious consideration, transplanting human brain organoids into animals could lend crucial insights into the origins and potential treatments of diseases like dementia and schizophrenia.

"This is still too futuristic, but that does not mean we should wait to decide on ethical guidelines. The concern is not so much a biological humanization of the animal, which can happen with any organoid, but a moral humanization, which is exclusive to the brain," worries Sawai.

Other concerns, he adds, include enhanced abilities: think *Planet of the Apes.* If animals develop human traits, then treating them sub-humanely would threaten human dignity, a core tenet of ethical practice. The paper notes that some people do not consider these outcomes unethical. Enhanced abilities without a change in self-consciousness is equivalent to using a higher animal in experiments, like shifting from mouse to monkey. And a change in dignity does not mean a change to human dignity. Instead, the change could result in a new type of dignity. Regardless, the authors believe that the possibility of unintended interactions between the transplanted brain organoid and the animal brain deserves precautionary consideration.

The biggest concern regarding brain organoid transplantation, however, does not involve animals. As research proceeds, the future will enable transplanting these structures into patients who suffered from sudden trauma, stroke, or other brain injury.

There are already a number of clinical trials that involve the transplantation of brain cells as a therapy for patients with such injuries or neurodegenerative diseases. Sawai proposes that the ethics behind these therapies could act as a paradigm for the ethics of brain organoids. "Cell transplantations change the way brain cells function. If something goes wrong, we can't just take them out and start over. But right now, cell transplantation is usually in just one location. Brain organoids would be expected to interact more deeply with the brain, risking more unexpected changes," he observes.

In late 2018, the international stem cell field condemned a Chinese scientist who genetically engineered human embryos that gave birth to twins. The actions of the scientist clearly violated international agreements and resulted in his prison sentence. To avoid a similar controversy and possible loss of public confidence in brain organoid research, the paper states explicitly that all stakeholders, including ethicists, policy-makers, and scientists need to remain in constant communication about progress in the field. The difference is that international agreements already prohibit human embryo engineering, but no consensus restricts brain organoid use.

"We need to regularly communicate with each other on scientific facts and their ethical, legal, and social implications," affirms Sawai. ▲

SCIENCE WITH INDUSTRY AND SOCIETY

Running LAPs together for citizen science

The University has implemented various measures... regarding pollution, ecotourism, and public education

Daisuke Akaishi looks calm and collected. Yet he does worry; the situation for native plants in the Ashiu Research Forest is not good. The biologist isn't lacking hope and a plan of action, however.

The deer population has exploded in recent years. As a result, Ashiu's forest is losing much of its native vegetation to the insatiable animals. Fence installation and hunting have slowed the damage. "But it may be a case of too little, too late," says the assistant professor.

For instance, broadleaf bamboo, or *sasa*, which once lushly carpeted the forest floor, is now so depleted that barren patches are visible throughout the forest.

Akaishi's team at the **Field Science Education and Research Center** organizes projects to preserve and repopulate native plants. "It's not merely an issue of the aesthetics of the forest," he says, pointing out that the ecological balance has been disrupted, causing a cascade of negative effects such as the destruction of microhabitats and food resources in the once-virgin forest.

According to Akaishi, in the mid-20th Century regional governments were following then popular plans to construct hydroelectric dams in the area. "Fortunately, the University ensured that Ashiu was spared that fate, in order to continue research and preservation of the forest ecology," he notes.

While Ashiu has indeed mostly survived human encroachment, it appears to be losing quickly to the deer. To address this, the University has implemented various measures and policies regarding preservation, ecotourism, and public education.

For example the **Link Again Program** Program — LAP — ran during 2018–19, bringing researchers and citizen groups together to share ideas and seek common solutions. Follow-on programs continue.

"One of the main challenges we face in recruiting more citizen groups and businesses," concludes Akaishi, "is the difficulty in convincing the public that businesses have no ulterior motives."

Nevertheless, judging from the enthusiastic public response to such initiatives, Akaishi's vision of citizen science has inspired the community to become responsible problem-solvers themselves.

GLOBAL ENDEAVORS

Strategic partnerships fostering mutual trust for effective **international collaboration**

Kyoto University has inaugurated a **strategic partnership program** to promote and extend its international network of collaboration. Committed to increase joint research initiatives and mobility for early career researchers, KyotoU currently has five strategic partner universities around the world.

The University announced its first open calls for matching funds for collaborative projects with its strategic partners in Europe, starting with the **University of Zurich** (UZH) in December 2020 and then **Universität Hamburg** (UHH) in May 2021. A joint selection committee with representatives from each partner university vetted the applications, and the successful candidates received funding to advance their research studies.

The award-winning researchers strive for innovation in fields ranging from medicine, neuroscience, artificial intelligence, disaster prevention and recovery, and plant science, to law and indology. These projects will establish new research alliances as well as deepening existing areas of cooperation.

An important byproduct of these matching funds is the mutual trust cultivated between Kyoto University and its European counterparts in the process of vetting applications for matching funds. Their close communication in designing the selection and review processes has deepened their team skills and mutual understanding. In order to achieve high-quality research results, building trust appears to be one valuable outcome of strategic partnerships.

Kyoto ASEAN Virtual Fields
drones, VR images, & aerial photographs using ICT

© University of Zurich


© Universität Hamburg

The Kyoto University ASEAN Center has been developing ICT (information and communication technology) support measures and online tools to enhance international student and faculty exchange activities that were impeded by the pandemic.

The first measure is the creation of video materials that allow students to experience fieldwork using ICT. The **Kyoto U-ASEAN Center Virtual Fields** website provides video teaching materials using aerial drone photography and VR images to capture forests, oceans, large-scale infrastructure construction sites, and experimental facilities of the University's overseas partner schools, accompanied by university faculty expert commentary.

While ensuring the safety of students and faculty, these video materials realistically reproduce education and research sites to increase motivation and interest in learning. The website is freely accessible not only to KyotoU students and faculty members but also to the general public.

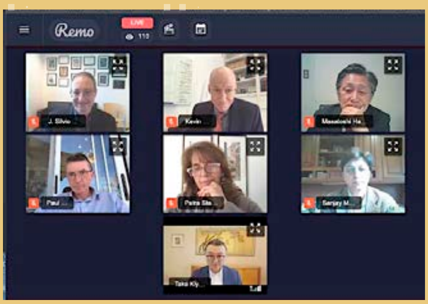
A second measure implements joint projects between ASEAN and Japan supporting a human resources development program for STI (science, technology, and innovation) coordinators. Under the formal endorsement of COSTI (the ASEAN Science, Technology, and Innovation Committee), the Center led a series of seven online seminars to cultivate STI coordinators in the ASEAN region.

The Center also reported the summary of joint projects on line at the 79th ASEAN COSTI meeting, attracting high expectations and awareness of STI coordinators for Japan and ASEAN to work together in the future.

www.oc.kyoto-u.ac.jp/overseas-centers/asean/en/virtual-fields/

Onsite lab: start-up and venture promotion from **KURC-SD**

The Kyoto University Research Center San Diego is an onsite laboratory in La Jolla, California, designed to help medical scientists work jointly with US-based academia and industry, and start-up ventures originating in KyotoU or partner academic institutions to develop technologies and products for international trade.



Kyoto University has established 12 locally-managed onsite labs in collaboration with overseas partners to date. The purpose of these labs is to promote world-leading research, recruit talented international students, and expand collaboration with industrial partners.

In October 2020, KURC-SD launched its Distinguished Scientist Lecture Series in cooperation with the University of California San Diego. This monthly series of online seminars features presentations by recognized authorities and specialists in the medical sciences, free of charge with prior registration. Twelve seminars to date have attracted over 1,600 researchers from all over the world.

Another important event is the **Kyoto University LifeScience Showcase @ San Diego**, held annually since 2020. The Showcase provides a platform for academia-based startup companies to deliver presentations on cutting-edge technologies and seeds in the fields of medical and life sciences, and to solicit possible investment from industrial partners to accelerate development and markets

for their discoveries in pharmaceuticals, regenerative medicine, and medical devices.

The first showcase was held in February 2020 and the second in March 2021. The latest attracted 18 startup companies, including five presentations from KyotoU. 216 research-ers, entrepreneurs, pharmaceutical companies, donors, venture capital firms, and institutional and private investors from Japan and abroad participated in this industry-academia networking event.

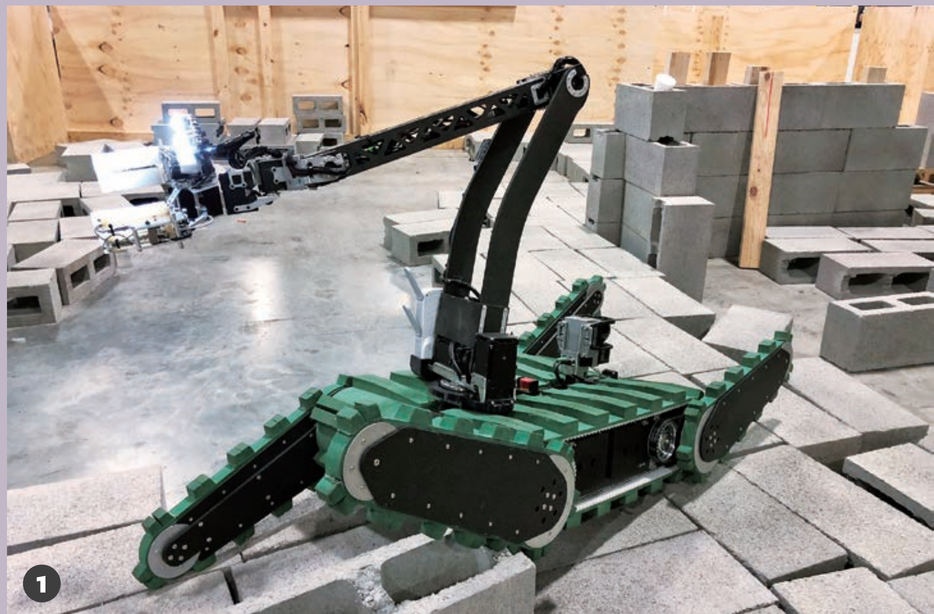
Planned for March 2022, the third showcase will accelerate research outcome utilization, contributing to the social implementation of innovative discoveries in collaboration with industrial partners.

www.kyoto-u.ac.jp/en/about/operation/designated/on-site-laboratories

The Mechatronics Lab on KyotoU's Katsura campus constantly hums with activity. The desks are covered with equipment and tools, as well as trophies that won't fit on the overflowing display shelf. A four-legged robot with a square body and an arm at the top sits on the concrete floor.

"Meet FUHGA2, winner of the RoboCup 2019 World Tournament." Tatsuya Takemori, team captain for the championship, gives a relaxed smile as he talks, leaning in as though introducing a colleague.

Takemori and his lab mates took part in the RoboCup Rescue Robot League in Sydney. In a mock disaster site, contestant robots are evaluated on criteria such as mobility and searching ability. The number of robots able to navigate rough terrain is increasing, but Takemori says with disdain, "Those doesn't interest us."



STUDENT VOICES

Confronting disaster: robot development with a dash of entertainment

Rescue Robot Development & Operation Team SHINOBI

TATSUYA TAKEMORI, (3RD YEAR DOCTORAL STUDENT, GRADUATE SCHOOL OF ENGINEERING)

1 The winning robot, FUHGA2, overcoming obstacles at a mock disaster site

2 Team members after winning the world tournament; their mentor, Professor Fumitoshi Matsuno of the Graduate School of Engineering, is second from left

3 Takemori's snake-shaped robot, for which he does the coding as well as manufactures the components using a 3D printer

His team prefers a unique approach. FUHGA2's arm is now stronger and more dextrous. "Many teams will go three or four years without replacing the base robot," says Takemori. "We rebuild ours from scratch every year, making it easier for us to test new ideas." This passion for innovation epitomizes the spirit of Kyoto University.

Takemori also has the soul of a show master. While working on the RoboCup, he chose a snake-shaped rescue robot as his research topic. In addition to crawling like something alive, this model can also shape its body into an arc to move forward like a caterpillar. The lab makes daily refinements, envisioning the use of the robot to navigate narrow spaces and obstacles at disaster sites, or to survey pipe installations under ordinary circumstances.

These complex movements are only useful if they serve a practical purpose. Takemori explains that an attempt to use the robots in disaster response activities in Okayama Prefecture in 2018 brought unexpected challenges to their attention, including how to deploy the robots in the first place. "We've gained a much better sense of the functions rescue robots need."

For example, on site a robot may quickly become snarled by obstacles and uneven surfaces. Takemori wracked his brain for answers to these problems. "It was an escalator that did it for me. I was just staring at one blankly when I hit upon the idea." The snake-shaped robot's joints have comb-shaped grooves like those on the steps of an escalator, and the grooves mesh with each other to achieve fluid movement. Capitalizing on its flexible range of motion, the lab's snake-shaped robot became the first of its kind to successfully climb and descend a ladder.

"What I want to build is a robot that is a step ahead of people's imaginations, so that when they see it they'll have to rethink their idea of what a robot is. I also want to explore their appeal as a source of entertainment." This sense of play, of wanting to astonish an audience, puts disaster scenarios in a new light. It seems that the day when Takemori's robots will fascinate people all over the world is not far off.

Eternal aesthetic

Artwork by KyotoU students, combined with artistic scenes as glimpsed by researchers

Colors

Location: Arashiyama station, Keifuku railway Arashiyama line
Photography: Railway Club
Mayo Ikeda (2nd year Faculty of Engineering)

A juxtaposition of the *kimono* forest, a popular illuminated textile installation at Arashiyama station, with the *Randen* tram. When night falls, the scene becomes dreamlike.

Sounds

From the male chorus suite
Yuki to hanabi (Snow and Fireworks)
I. Katakoi (Unrequited Love)
Performed by: KyotoU Glee Club
Lyrics: Hakushû Kitahara; Composer: Takehiko Tada

Watching the arrival and departure of the tram at the unmanned platform, I felt indescribably lonely. The light that dappled the dark night with color, gorgeous yet tranquil, was like falling petals. I hope that this piece of music, in which the singer addresses his love for a woman, might add to the photo's allure.

Words

Suggested by: Caruta Circle Boiler
Kokin wakashû *(vol 5) Autumn 294*
(Hyakunin isshu *no 17, translation by Joshua Mostow*)

The song gives an impression of autumn colors, unrequited love, and a flowing river, similar to the elements of this poem. Further, the Heian period poet Ariwara no Narihira composed this verse for the emperor's wife, a woman whom he had once loved.

ちはやぶる
神代も聞かず
竜田川
からくれなゐに
水くくるとは

Unheard of
even in the legendary age
of the awesome gods:
Tatsuta river in scarlet
and the water flowing under it

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