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**asia**

RESEARCH NEWS

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# Bringing disc to light



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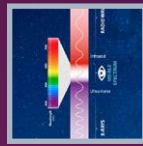
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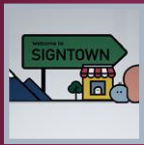
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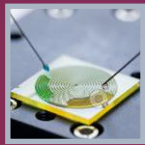
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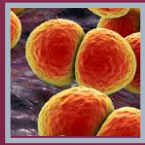
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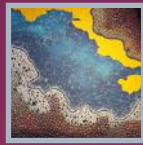
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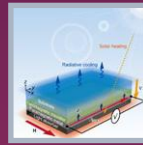
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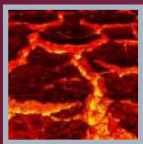
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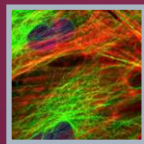
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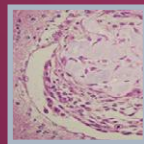
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# page 56 BONE REGENERATION





A global health threat predicted to reach 10 million deaths a year by 2050.

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Credit: Patricia Ciprian Kis | 123rf

Evolution is one of my favourite words in the English language. A significant term in science, something I hear whenever my son talks about Pokémon and personally, the word represents the freedom to embrace change as the world changes around us.

ResearchSEA Limited, the parent company of Asia Research News, celebrates its 20th anniversary in two years time. Over the years, we have continuously evolved, ushering in new concepts and strengthening relationships. You can read our origin story and get tips on science communication in our [Beyond the Journal](#) blog.

This issue carries stories on evolution, the search for origins of life on Earth and other planets, how evolution of one species can help the conservation of another and how scientists themselves have evolved in response to a pandemic and a coup. We also bring you a

special feature on antimicrobial resistance, a silent pandemic that scientists are sounding loud alarms on whilst working hard to stay ahead of it.

Read about a theme park visit that led to a world's first, plane safety inspired by a woodpecker's head, mathematics insights gained by reconstructing a crushed can, plans to turn the public into oceanographers, environmentally friendly AI, advances in cancer stem cells, regenerating damaged tissue and bone, robotic hands and night vision in cars.

We hope you enjoy reading these stories as much as we've enjoyed bringing them to you.

Last but not least, we invite you to check out our [Giants in History](#) pages to read about fascinating researchers who paved the way for today's scientists; because role models matter.

  
Magdeline Pokar  
Founder and CEO

The science of **communication**

You've got questions...

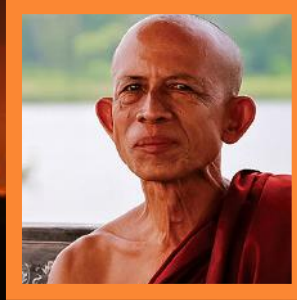
We have answers.

Find out more at [asiaresearchnews.com/blog](http://asiaresearchnews.com/blog)



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Countries often emulated each other, without giving enough consideration to the impacts on different groups in their societies, such as women, schoolchildren, daily wagers, migrants and people with disabilities.



# SOCIAL SCIENCE MISSING FROM ASIA'S COVID-19 RESPONSE

**Policy-makers should engage more closely with social scientists to understand the socio-economic, cultural and political contexts behind the behaviours we need to change in response to global crises.**

A region-wide assessment has found that opportunities were missed to involve social scientists in national COVID-19 response strategies in Southern and South-east Asia. The report, “The Role of Social Sciences in COVID-19 responses in Asia”, was a collaboration between the Global Development Network and the Asia Research Centre at Universitas Indonesia, with support from the International Development Research Centre, Canada.

“COVID-19 containment measures in Asia have not benefited from understanding the contexts of how the pandemic is spreading,” says Inaya Rakhmani, director of Universitas Indonesia’s Asia Research

Centre. “Individuals have been blamed for not modifying their behaviours without understanding what is behind their reluctance. Social science research plays a critical role in providing insights into human behaviour.”

A team of researchers examined how social science was mobilized in 11 Asian countries as part of national COVID-19 response strategies. They conducted literature reviews and interviews with various stakeholders to determine the extent of involvement of social scientists in decision-making mechanisms, how pandemic-related social science research was funded, and to evaluate current and

emerging initiatives led by social scientists in the region.

The researchers found that governments often viewed the pandemic as a medical and security issue, overlooking its socio-cultural dimensions. Bureaucratic and sometimes military personnel dominated many national pandemic commissions, with scientist involvement largely restricted to the fields of medicine and macro-economics. Social scientist involvement, on the other hand, was minimal, limited to managing large datasets and statistical information, and was mainly at lower administrative levels.

“Opportunities were missed to design

Credit: Images licensed through Dreamstime.com



Individuals have been blamed for not modifying their behaviours without understanding what is behind their reluctance.

effective, context-specific COVID-19 response policies,” says Francesco Obino, head of programs at the Global Development Network. “Countries often emulated each other, for example by implementing lockdowns, without giving enough consideration to the impacts on different groups in their societies, such as women, schoolchildren, daily wagers, migrants and people with disabilities. The knowledge and capacities to understand those impacts exist, but were only marginally mobilised by COVID-19 taskforces.”

“Policymakers in Asia are not recognizing some of the social dimensions of health,” adds cultural anthropologist Rosalia Sciortino

of Thailand’s Mahidol University. “For example, social science research can reveal the socio-economic and cultural contexts that impact compliance to mask-wearing and social distancing measures and perceptions about vaccines. If we understand the contexts, we can design more successful context-specific strategies.”

Despite the missing connection with policy-makers, Asia’s social scientists were able to spark public discussions by communicating their findings through the media. These discussions sometimes impacted government decision-making. Social scientists also partnered with non-governmental organizations to use

their research to improve work availability during the pandemic in countries like Malaysia, the Philippines and Thailand. The field also benefited from corporate and international funding despite a comparative lack of national investment in social science research related to the pandemic.

“Social scientists must break down the barriers standing in the way of a more integrated involvement in multi-dimensional crises, such as the COVID-19 pandemic and climate change,” says Sciortino. “We need to enhance the visibility of what we do to ensure that social sciences fully contribute to reshaping our common future in a more sustainable and just manner.”

# BETTER MEMRISTORS FOR BRAIN-LIKE COMPUTING

Neurone-like junctions made of mixed oxide-based materials could reduce the massive energy consumption of artificial intelligence operations.

Scientists are getting better at making neurone-like junctions for computers that mimic the human brain's random information processing, storage and recall. Fei Zhuge of the Chinese Academy of Sciences and colleagues reviewed the latest developments in the design of these 'memristors' for the journal *Science and Technology of Advanced Materials*.

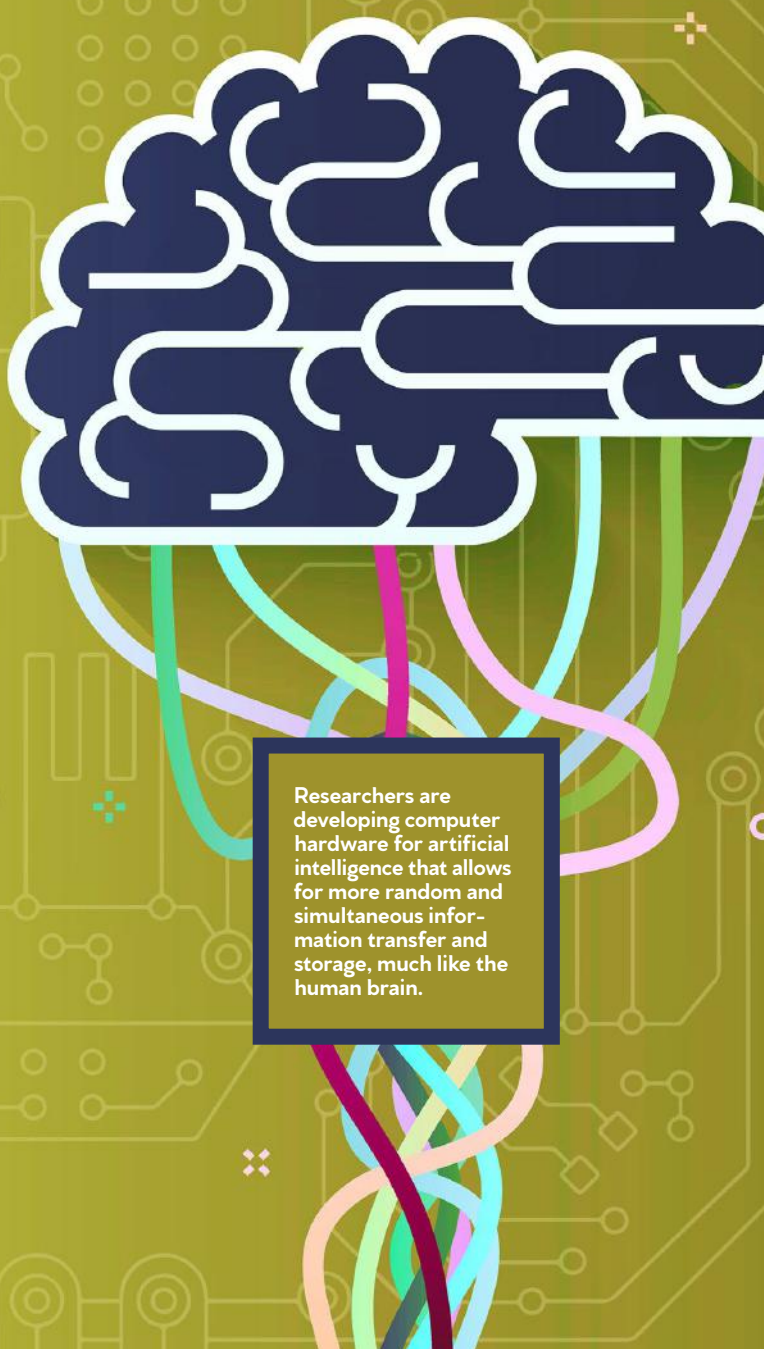
Computers apply artificial intelligence programs to recall previously learned information and make predictions. These programs are extremely energy- and time-intensive: typically, vast volumes of data must be transferred between separate memory and processing units. To solve this, researchers have been developing computer hardware that allows for more random and simultaneous information transfer and storage, much like the human brain.

Electronic circuits in these 'neuromorphic' computers include memristors that resemble the synaptic junctions between neurones. Energy flows through a material from one electrode to another, much like a neurone firing a signal across the synapse to the next neurone. Scientists are now finding ways to better tune this intermediate material so the information flow is more stable and reliable.

"Oxides are the most widely used materials in memristors," says Zhuge. "But oxide memristors have unsatisfactory stability and reliability. Oxide-based hybrid structures can effectively improve this."

Memristors are usually made of an oxide-based material sandwiched between two electrodes. Researchers are getting better results when they combine two or more layers of different oxide-based materials between the electrodes. When an electrical current flows through the network, it induces ions to drift within the layers. The ion movements ultimately change the memristor's resistance, which is necessary to send or stop a signal through the junction.

Memristors can be further tuned by changing the compounds used for electrodes or adjusting the intermediate oxide-based materials. Zhuge and his team are currently developing optoelectronic neuromorphic computers based on optically-controlled oxide memristors. Compared to electronic memristors, photonic ones are expected to have higher operation speeds and lower energy consumption. They could be used to construct next generation artificial visual systems with high computing efficiency.



Researchers are developing computer hardware for artificial intelligence that allows for more random and simultaneous information transfer and storage, much like the human brain.

# ABSORBING IMPACT: INSIDE THE HEAD OF A WOODPECKER

Inspired by the woodpecker's ability to strike trees with its beak rapidly and repeatedly without injury, engineers in Malaysia have used computer simulations to find ways to improve the design of composite beams used in impact-prone structures.



Scientists at Universiti Malaysia Sarawak (UNIMAS) are using computational modelling to optimise the ability of composite sandwich beams to absorb strong impacts. They applied their approach to a beam design inspired by the woodpecker's head, changing aspects of the structure to find the optimal solution. The findings were published in the journal *Composite Structures*.

"Sandwich beams are used in construction and the aviation and automotive industries due to their superiority over many conventional structures in terms of their enhanced energy absorption, light weight, stability, and ability to protect occupants during a crash," says UNIMAS structural engineering lecturer, Ahmad B. H. Kueh. Such beams are made of an upper and lower skin sandwiching a light-weight inner core. Much research has been done on a variety of sandwich beam designs, involving different types and shapes of inner cores. Core designs have been geometrically inspired, employed

the concepts of Japanese folding art, or have even been driven by natural designs found in the animal and plant kingdoms.

Among these, a design inspired by the woodpecker's head has shown promise. However, there is still much room for improvement. Kueh and his colleagues used an engineering software tool, called ABAQUS, to simulate what might happen to woodpecker-inspired sandwich beams upon impact.

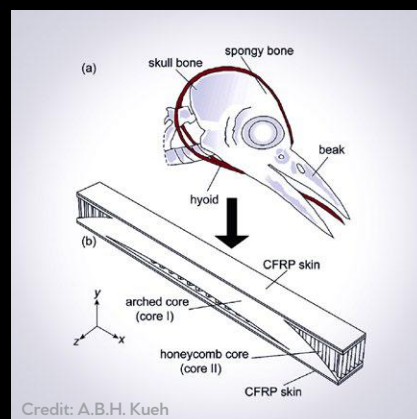
They assumed a beam made with outer skins of polymer laminate reinforced with carbon fibre. The inner core was composed of two parts: a surrounding arch made of hot glue and an aluminium-based honeycomb. Experimentally-known details of the various materials, such as density, stiffness and tensile strength, were input into the software program. The researchers then tested how impact affected the beam when the hot glue arch was thinner or thicker and the width of the arch's legs, called leg span, changed.

The simulations showed that a thin arch

with a short leg span resisted impact best.

The beam models with the thickest arches showed the highest contact force, damage area and energy absorption. Thinner arches were maximally stressed, but performed better due to their ability to withstand repeated blows without damage.

The team recommends further research to explore the use of stiffer and less dense materials.



Credit: A.B.H. Kueh

The beam's design is inspired by the ability of the woodpecker's head to protect its brain from injury.

**Did you know?**

Plastics can degrade in the ocean into tiny microplastics that have been found in the deep oceans, the Antarctic ice and marine animals. Scientists estimated in 2015 that there were up to 51 trillion microplastic particles floating in surface waters worldwide.

# FLOATING SENSORS TO GATHER OCEAN DATA

Device designers at The University of Tokyo are developing cheap and accessible ways to monitor and explore the sea.

The oceans carry information about climate change, food and natural resources, yet only 5% of the world's oceans have been fully explored. Researchers in Japan are working to change that by developing cheap and accessible floating ocean sensors that can gather and analyse critical data from the sea, as well as track plastic pollution.

The project, called OMNI (Ocean Monitoring Network Initiative), is led by design experts at The University of Tokyo's Institute of Industrial Science (IIS).

"The purpose of OMNI is to take a different approach to marine measurement and sensing," says Miles Pennington of the

DLX Design Lab at the IIS.

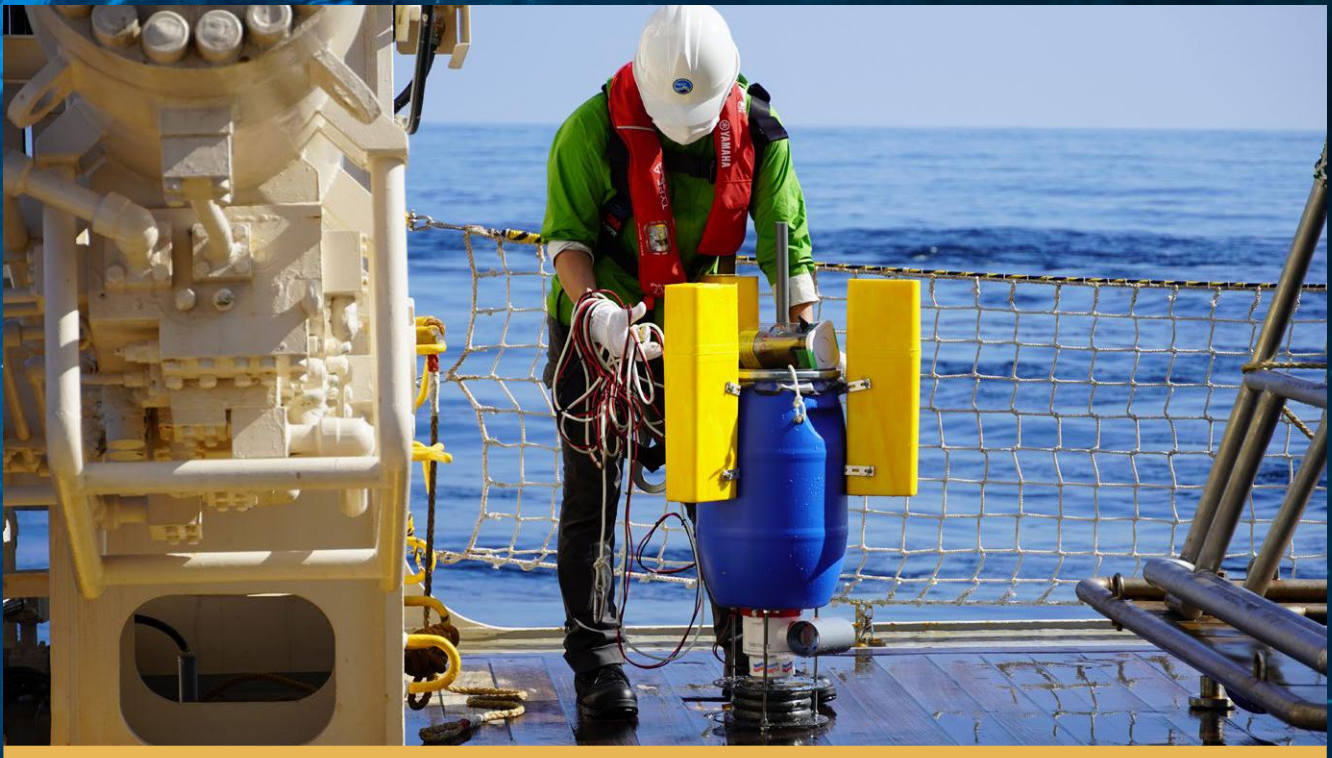
The project's team is currently testing prototype devices in collaboration with multiple partners, such as schools, companies and local communities. One of the project's goals is to allow participants to create their own ocean monitoring system to collect information on temperature, salinity, currents and microplastic pollution. Results will be released and discussed in a series of local workshops.

The OMNI approach has speed on its side. The high-powered sensors typically used in ocean monitoring are expensive and require specially trained operators.



OMNI is a flexible use, low cost, easily deployable, ocean sensing system to gather detailed and diverse data from the seas.

Credit: (foreground images) DLX Design Lab



OMNI Microplastics Device test

OMNI devices have been designed using consumer electronic sensor technologies to keep system costs low. This will allow a much broader base of people to become involved in ocean monitoring, thus producing much quicker results.

In the future, OMNI's sensing technology, device designs, systems and gathered data will be freely accessible by anyone at any time.

The data will help decision makers develop sustainable policies to maintain the health of the ocean environment. The project should also prove educational, to help people learn more from the oceans and increase awareness

among the general public about the fragile marine habitat.

By working in this people-oriented and user-friendly way, the project aims to maximise engagement, data collection and use. "We hope the project will make people more interested in their oceans and help them think about how to use them in a more meaningful way," says Pennington. "We also hope it will become an open access platform that can provide comprehensive information at sea, similar to Google Maps on land, which will lead to innovation and the creation of new businesses."



Students at an OMNI Microplastics workshop



More about OMNI: Ocean Monitoring Network Initiative



# UNDERSTANDING THE LOW NITROGEN BLOOM

**Scientists from Hokkaido University and colleagues have identified a pathway that accelerates plant flowering in low-nitrogen soils – a finding that could help enhance agricultural production.**

Nitrogen is one of the three macronutrients required for plants to grow and develop, along with phosphorus and potassium. Nitrogen-rich conditions induce plant growth, particularly stems and leaves, while delaying flowering. In some plants, low nitrogen conditions lead to a change from growth mode to reproductive mode, accelerating flowering. However, the molecular mechanisms that regulate flowering under these conditions are not known.

A team of scientists, led by Hokkaido University plant physiologist Takeo Sato, has revealed the molecular mechanism responsible for accelerating flowering in the *Arabidopsis* plant under low nitrogen conditions. Their findings were published in the journal *PNAS*.

*Arabidopsis* is often used to study plant biology and scientists have been able to compile an extensive database of its protein expression. In the current study, the team identified a set of proteins that are activated when nitrogen levels change. One of these was the gene regulator FLOWERING BHLH 4 (FBH4). The scientists conducted experiments using

FBH4-deficient plants and confirmed the protein was responsible for accelerated flowering under low-nitrogen conditions.

Further investigation suggested that FBH4 is extensively phosphorylated by another protein called SnRK1. Low-nitrogen conditions suppress SnRK1 activity, which in turn results in FBH4 dephosphorylation. The dephosphorylated FBH4 moves to the nucleus to activate genes responsible for flowering. It is also responsible for controlling the expression of other genes vital for plant survival under low nitrogen conditions, particularly those related to nitrogen recycling and remobilization.

The scientists conclude that inadequate nitrogen conditions appear to trigger FBH4 use by *Arabidopsis* plants to precisely control genes related to developmental and metabolic processes required for flowering. “The FBH family of genes is present in major crop plants. Manipulating their activities might be an effective way to control when crops flower and thus sustainably enhance agricultural production,” says Sato.

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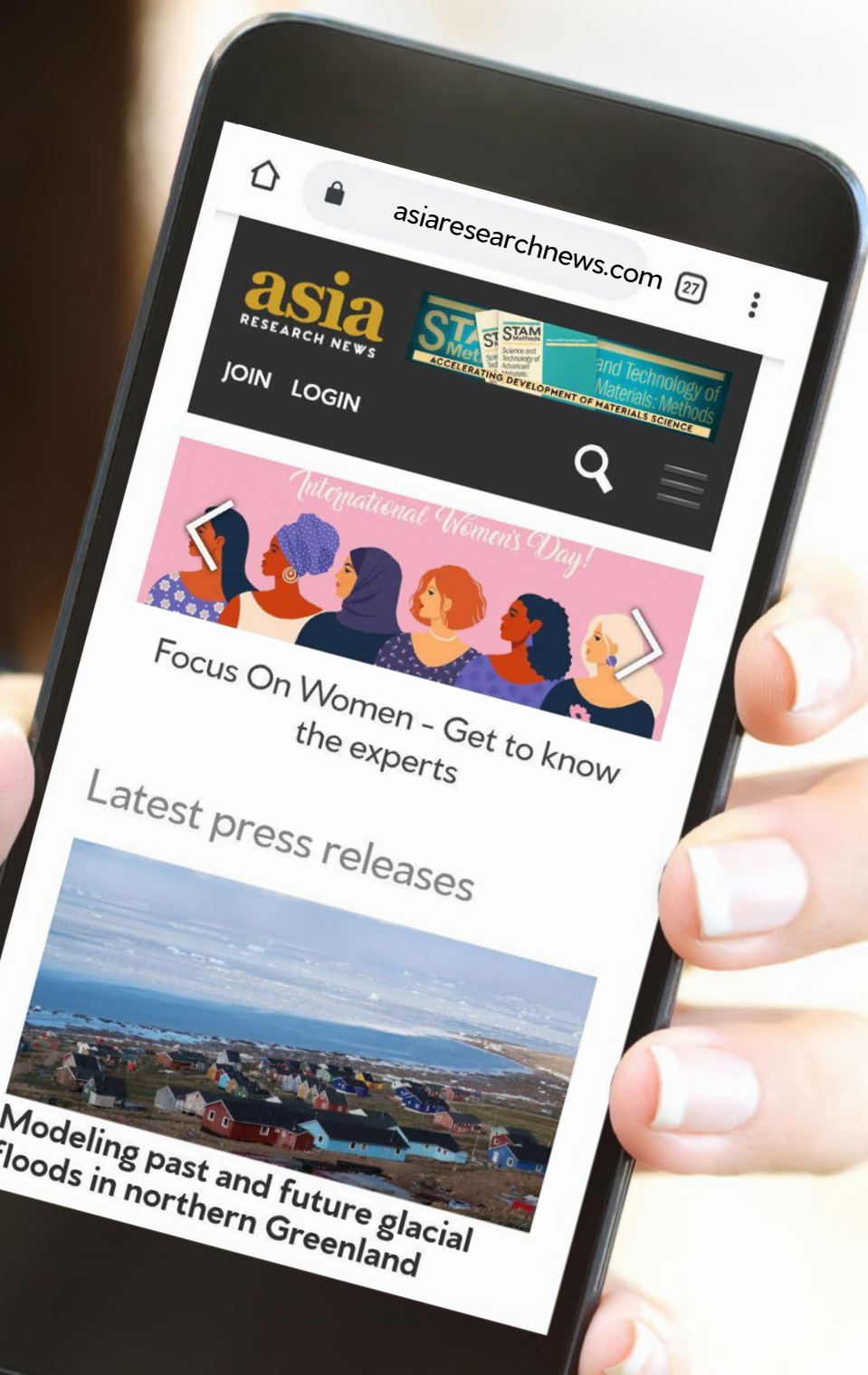
**In some plants, low nitrogen conditions lead to a change from growth mode to reproductive mode, accelerating flowering.**



Takeo Sato, with *Arabidopsis* plants in the culture room.

Credit: Creative Commons | Sui-setz

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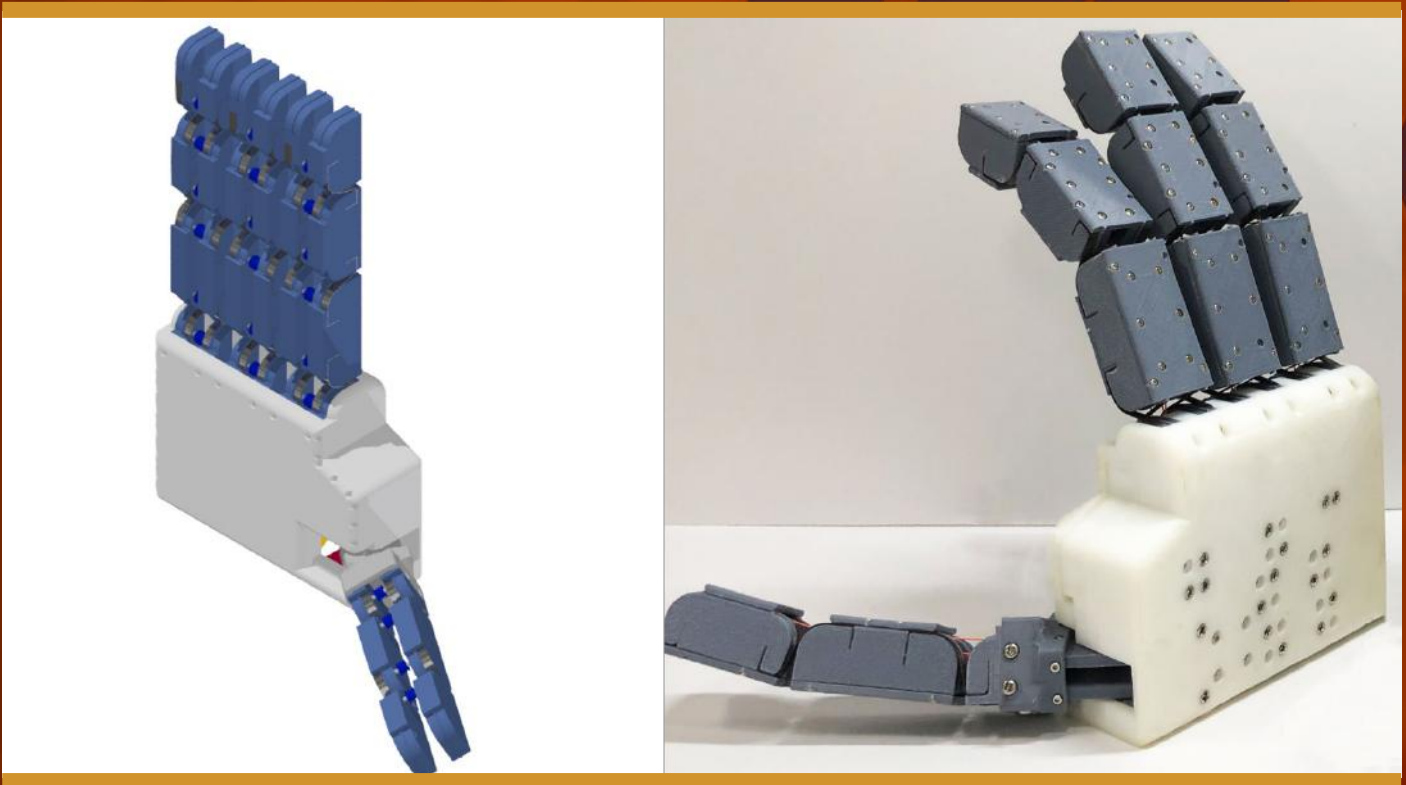
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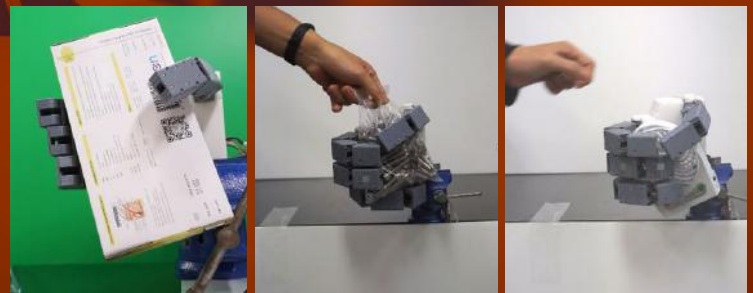
# A HELPING HAND FOR WORKING ROBOTS

A reimagined robot hand combines strength with flexibility and resilience, sidestepping problems with existing designs.



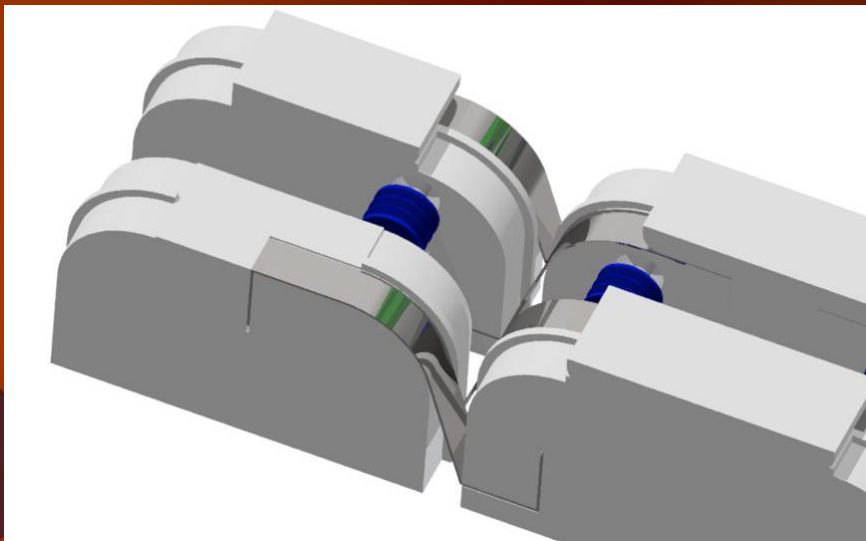
The crossed flexure hinge (CFH) system in this robot hand allows more shock absorbcency than a pin-jointed robotic hand.

The flexible robotic hand can grasp objects of various shapes weighing up to four kilograms.



Credit (foreground images): Bio-Robotics & Mechatronics Laboratory, Department of Robotics Engineering, DGIST.

## STORY CONTINUED



The CFH is made of two metal strips arranged in an X-shape that can flex or bend in one position while remaining rigid in others.

Robotics engineers at South Korea's Daegu Gyeongbuk Institute of Science and Technology (DGIST) have developed and tested a new human-like mechanical hand that combines the benefits of existing ones while eliminating their weaknesses. The design is described in the journal *Soft Robotics*.

Until now, competing robotic hand designs offered a trade-off between flexibility, strength and durability. One commonly used design employing rigid pin-like finger joints can lift heavy payloads, but is easily damaged in collisions, particularly if hit from the side. Meanwhile, flexible silicon-based hands are more difficult to break and grasp differently-shaped objects better, but fall short on lifting power. "Smart industrial and cooperative robots that interact with humans need resili-

ence and strength," says Dongwon Yun, who heads the DGIST BioRobotics and Mechatronics Lab.

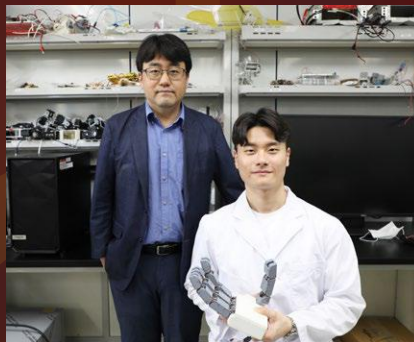
The DGIST research team investigated whether a partially flexible robot hand, with joints made of rigid links connected to a structure known as a crossed flexural hinge (CFH), could improve lifting power while minimizing damage in the event of a collision. Generally, a CFH is made of two strips of metal arranged in an X-shape that can flex or bend in one position while remaining rigid in others.

The team made the metal strips that serve as the CFH connecting joints that allow the robotic fingers to curve and straighten like in a human hand. They then demonstrated the robotic hand's ability to grasp different objects, including a box of tissues, a small fan and a wallet. The

CFH-jointed robot hand was 46.7% more shock absorbent than a pin-jointed robotic hand. It was also stronger than fully flexible robot hands, and was able to hold objects weighing up to four kilograms.

Further improvements are needed before robots with these partially-flexible hands are able to go to work alongside or directly with humans. The researchers note that additional analyses are needed to determine the most efficient materials for hand design, while further field experiments will help pinpoint the best practical applications.

"The industrial and healthcare settings, where robots are widely used, are dynamic and demanding places, so it's important to keep improving robot performance," says DGIST engineering PhD student Junmo Yang, the study's first author.



Prof Dongwon Yun (Left) and PhD student Junmo Yang.

# DYE-BASED DEVICE SEES THE INVISIBLE

**Devices that can see shortwave infrared light, which is invisible to the naked eye, could soon become cheaper and more accessible to a broader consumer base.**

Scientists have designed an organic dye-based device that can see light waves in the shortwave infrared (SWIR) range. The device is easy to make using cheap materials and is stable at high temperatures. The findings, published in the journal *Science and Technology of Advanced Materials*, could lead to more widespread use of inexpensive consumer SWIR imaging and sensing devices.

The human eye can only detect a very narrow segment of the electromagnetic spectrum, from around 400 to 700 nanometers. The SWIR region, on the other hand, extends from 1,000 to 2,500 nanometers. Specially designed cameras can take images of objects that reflect waves in the SWIR region. They are used for improving night vision, in airborne remote sensing, and deep tissue imaging. They also help assess the composition and quality of silicon wafers, building struc-

tures and even food produce.

“These cameras are typically difficult to manufacture and are quite expensive, as they are made of inorganic semiconductor photodiode arrays interconnected with read-out integrated circuitry,” says Roland Hany of the Swiss Federal Laboratories for Materials Science and Technology.

Hany worked with colleagues in Switzerland and Italy to design an organic dye-based SWIR upconversion device that efficiently converts shortwave infrared light to visible light.

The device uses organic (carbon-based) components: a squaraine dye-coated flexible substrate combined with a fluorescent organic light-emitting diode (OLED). When the dye absorbs SWIR waves, an electric current is generated and directly converted into a visible image by the OLED.

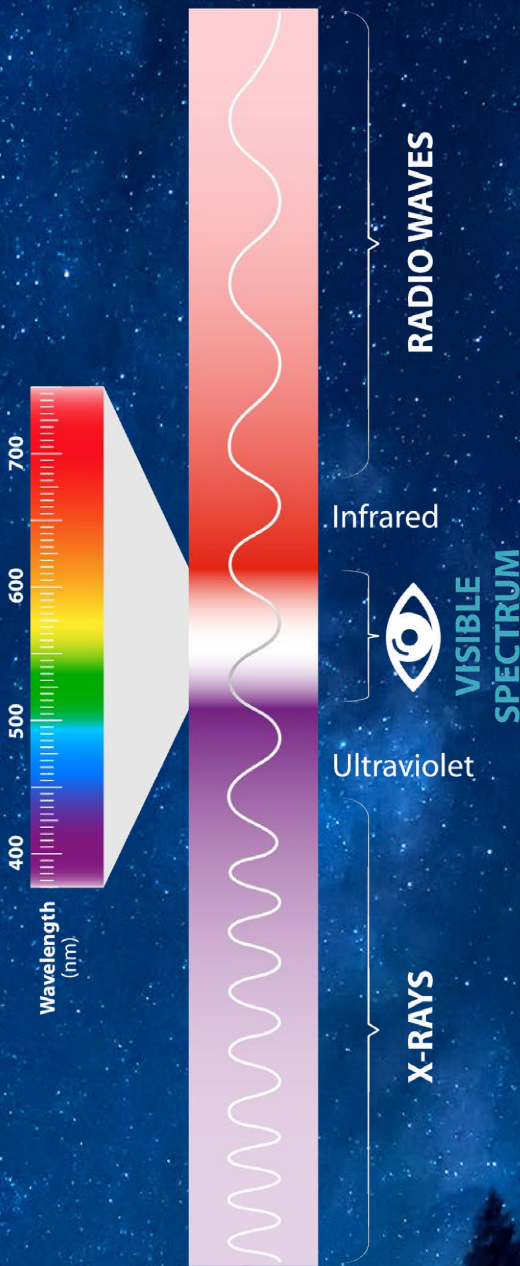
The team had to play with the molecular

composition of several squaraine dyes to get them to absorb specific wavelengths. Ultimately, they synthesized squaraine dyes that absorb SWIR light beyond 1,200 nanometers and remained stable up to 200°C. The finished dye-based device performed stably for several weeks under normal laboratory conditions.

“All-organic upconverters could lead to applications that can’t be realized with current technology. For example, invisible night vision devices can be directly integrated into car windscreens without affecting the visual field,” explains Hany.

The team is now working on shifting the dye’s absorption further into the SWIR range. They are also using machine learning techniques to find new dye molecules capable of sensing SWIR waves. Finally, the team aims to improve device stability and sensitivity.

# VISIBLE AND INVISIBLE LIGHT



Credit: 123rf | designua

The human eye can detect a very narrow segment of the electromagnetic spectrum, from around 400 to 700 nanometers. The shortwave infrared extends from 1,000 to 2,500 nanometers.



**This development could lead to applications that can't be realized with current technology. For example, invisible night vision devices can be directly integrated into car windshields without affecting the visual field.**



# ACCELERATING DEVELOPMENT OF MATERIALS SCIENCE



**NIMS** National Institute for Materials Science



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# IMPROVING MACHINE LEARNING FOR MATERIALS DESIGN

**A quick, cost-effective approach improves the accuracy with which machine learning models can predict the properties of new materials.**

A new approach can train a machine learning model to predict the properties of a material using only data obtained through simple measurements, saving time and money compared with those currently used. It was designed by researchers at Japan's National Institute for Materials Science (NIMS), Asahi KASEI Corporation, Mitsubishi Chemical Corporation, Mitsui Chemicals, and Sumitomo Chemical Co and reported in the journal *Science and Technology of Advanced Materials: Methods*.

"Machine learning is a powerful tool for predicting the composition of elements and process needed to fabricate a material with specific properties," explains Ryo Tamura, a senior researcher at NIMS who specializes in the field of materials informatics.

A tremendous amount of data is usually needed to train machine learning models for this purpose. Two kinds of data are used. Controllable descriptors are data that can be chosen without making a

material, such as the chemical elements and processes used to synthesize it. But uncontrollable descriptors, like X-ray diffraction data, can only be obtained by making the material and conducting experiments on it.

"We developed an effective experimental design method to more accurately predict material properties using descriptors that cannot be controlled," says Tamura.

The approach involves the examination of a dataset of controllable descriptors to choose the best material with the target properties to use for improving the model's accuracy. In this case, the scientists interrogated a database of 75 types of polypropylenes to select a candidate with specific mechanical properties.

They then selected the material and

extracted some of its uncontrollable descriptors, for example, its X-ray diffraction data and mechanical properties.

This data was added to the present dataset to better train a machine learning model employing special algorithms to predict a material's properties using only uncontrollable descriptors.

"Our experimental design can be used to predict difficult-to-measure experimental data using easy-to-measure data, accelerating our ability to design new materials or to repurpose already known ones, while reducing the costs," says Tamura. The prediction method can also help improve understanding of how a material's structure affects specific properties.

The team is currently working on further optimizing their approach in collaboration with chemical manufacturers in Japan.

Our design can be used to predict difficult-to-measure data using easy-to-measure data, accelerating the design of new materials, while reducing the costs.



# SIGN LANGUAGE FOR ALL

**Computer game uses a camera and AI-based movement recognition to teach sign language to a broader public.**

Technology that can reliably assess the accuracy of sign language promises a step change to help hearing people better communicate with the deaf community.

Employing artificial intelligence (AI)-based sign language recognition, a new game called SignTown teaches the use of signs for typical activities and, crucially, provides immediate feedback on player accuracy.

The game is a collaboration between The Chinese University of Hong Kong (CUHK), Google, The Nippon Foundation and Kwansai Gakuin University in Japan. It was launched on 23 September 2021, the International Day of Sign Language.

Nearly one in every 1,000 babies worldwide are born with hearing impairments. "There is a real need for hearing people who live and deal with this population to learn sign language and be able to communicate with them," says Felix Sze of CUHK's Centre for Sign Linguistics and Deaf Studies (CSLDS). "SignTown aims to bridge the gap between the two worlds."

SignTown is the first step of [Project Shuwa](#), which aims to significantly improve sign language recognition models. The research team believes that by teaching hearing people to sign, the online game will help the deaf community feel more included.

The game puts players in a virtual town where sign language is the official way to communicate. They use sign language in front of their computer cameras to complete tasks, such as packing for a trip, staying at a hotel, or ordering food in a café. The AI-powered recognition model provides immediate feedback on signing accuracy.

Previous sign language recognition models were not accurate enough because of weaknesses in the way they analysed visual-gestural language data. Sign language involves a range of gestural information, including hand, head and body movements, facial expressions and mouth shapes. Signing without these subtleties can lead to messages that are grammatically incorrect or that are difficult to interpret.

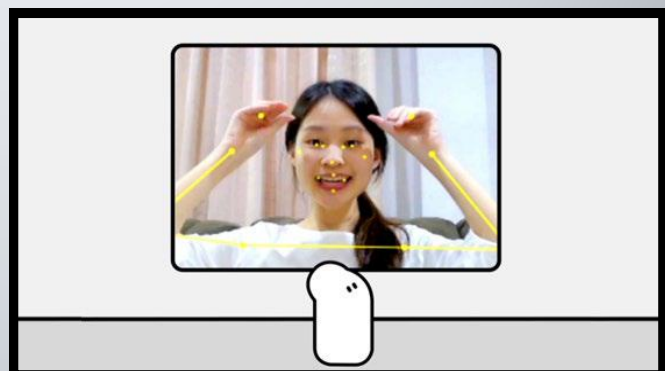
While sign languages vary from one country to another, phonetic features, including hand shapes, orientations and movements, are universal and the number of possible combinations is finite, making recognition models possible. Typically, complicated equipment, such as 3D cameras and gloves with sensors, has been needed to recognise signing in a 3D space.

Project Shuwa addressed this by developing a machine learning model that can use a standard camera to recognise, track and analyse 3D hand and body movements, as well as facial expressions.

The game allows users to choose between Japanese or Hong Kong Sign Language, with more options to become available in the future.

The project next aims to generate a sign dictionary and an automatic translation model that recognises sign language conversations and converts them into spoken language using computer and smartphone cameras.

"There is still a long way to go, but SignTown is opening the door to many more opportunities for people around the world to learn about sign language in real life situations," says CSLDS computer officer Cheng Ka Yiu, who was involved in the development of the game. "We are latching onto advanced technology to build an inclusive and harmonious society with equal opportunities."



More about [Signtown](#)





# GIVING LIQUID FLOW A GUIDING HAND

A surprising tree-inspired discovery is helping scientists design surfaces that encourage different liquids to move in varying directions.



Credit: Araucaria araucana by Marco Almbauer via Wikimedia Commons

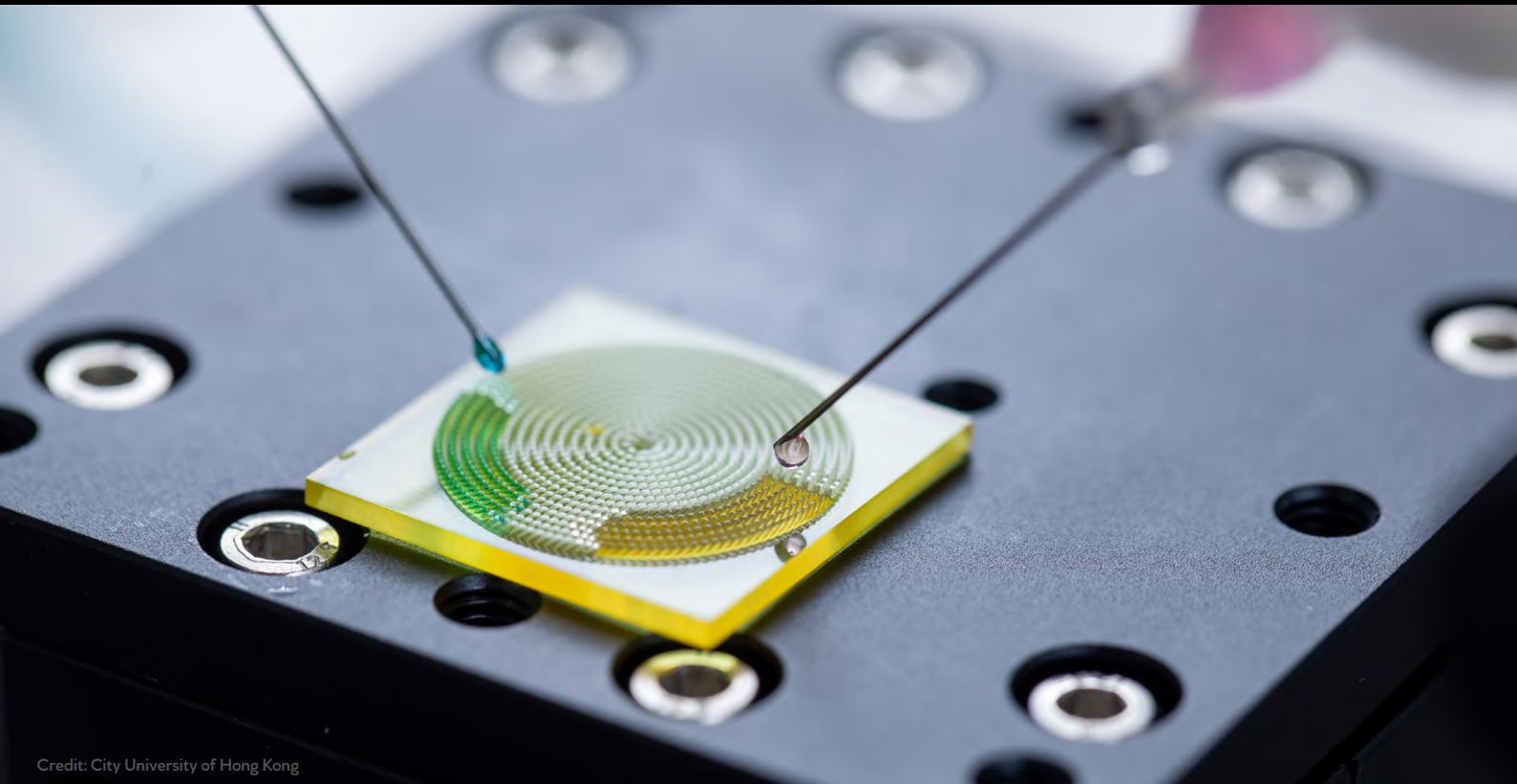
Liquids with different surface tensions can spread along the same 3D surface in different directions, a discovery that overturns conventional understanding of liquid movement. The finding, inspired by studies of a tree leaf, was published by scientists at City University of Hong Kong (CityU) in the journal *Science*. It could lead to the use of 3D surface structures to manipulate liquid flow, with applications in microfluidics and electronics.

“For the past two centuries, conventional understanding has been that a liquid deposited on a surface tends to move in a direction that reduces surface energy. This means its movement is largely determined by the surface’s structure and not by the liquid’s properties,” says CityU mechanical



**It was like a miracle observing the different directional flows of various liquids. This was the first recorded observation of this kind in the scientific world.**

Credit: City University of Hong Kong



Credit: City University of Hong Kong

engineer Zuankai Wang.

But the unique surface structure of a leaf from the Araucaria tree caught the attention of one of Wang’s former post-docs, Shile Feng, while at a theme park in Hong Kong. The leaf has periodically arranged ratchets that tilt towards the leaf’s tip. Each ratchet curves from top to bottom and side to side, has a smooth under surface, and a tip.

Back at the lab, Feng, Wang and their colleagues were surprised to find that liquids with different surface tensions spread in opposite directions on the leaf.

This led them to design a surface inspired by the leaf, with one-millimetre, 3D-printed, polymer ratchets organized in concentric circles. They found that

different water-ethanol mixtures with varying surface tensions either spread forwards, backwards or in both directions on the horizontally-placed structure.

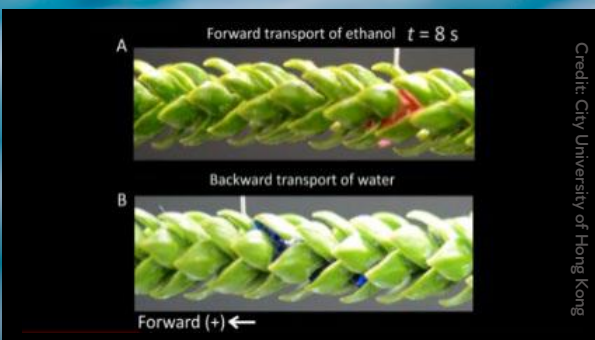
“The rational design of the novel ratchets enabled liquids to ‘decide’ their spreading direction based on the interplay between their surface tension and the surface’s structure,” says Wang. “It was like a miracle observing the different directional flows of various liquids. This was the first recorded observation of this kind in the scientific world.”

Specifically, liquids with high surface tension, like water, were pinned at the tip of the ratchet. Water was then able to move backwards against the ratchet’s tilt because the space between ratchets

was similar to water’s capillary length, a measure governed by gravity and surface tension. In contrast, low surface tension drove liquids like ethanol forwards along the ratchet’s tilt.

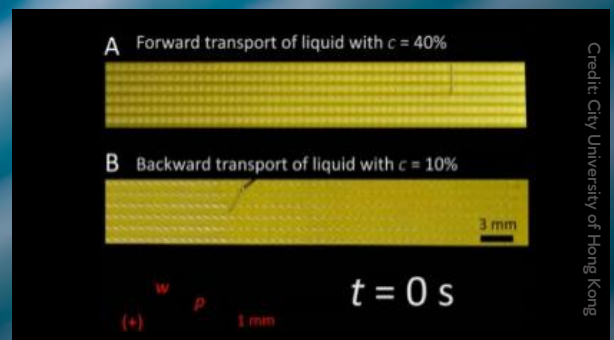
“By adjusting the proportion of water and ethanol in the mixture, we were able to change the mixture’s surface tension and manipulate the liquid flow direction,” says CityU mechanical engineer Pingan Zhu, who was also involved in the study.

The findings provide a way to guide the flow of liquid to a target destination, opening a new avenue for applications in microfluidics design, better heat transfer applications to cool computers and electronics, and in smart liquid sorting.



Credit: City University of Hong Kong

Liquid transport on an Araucaria leaf



Credit: City University of Hong Kong

Liquid transport on the Araucaria leaf-inspired surface

# STIMULATING BLOOD VESSEL FORMATION WITH MAGNETS

**A magnetic field could boost blood vessel growth to regenerate damaged tissues.**

A magnetic field can be used to stimulate blood vessel growth, according to a study published in the journal *Science and Technology of Advanced Materials*. The findings, by researchers at the Técnico Lisboa and NOVA School of Science and Technology in Portugal, could lead to new treatments for cancers and help regenerate tissues that have lost their blood supply.

“Researchers have found it challenging to develop functional, vascularized tissue that can be implanted or used to regenerate damaged blood vessels,” says Frederico Ferreira, a bioengineer at Técnico Lisboa’s Institute for Biosciences and Bioengineering. “We developed a promising cell therapy alternative that can non-invasively stimulate blood vessel formation or regeneration through the application of an external low-intensity magnetic field.”

The researchers worked with human mesenchymal stromal cells from bone

marrow. These cells can change into different cell types, and also secrete a protein called VEGF-A that stimulates blood vessel formation.

The research team, including Ana Carina Manjua, Frederico Ferreira, and Carla Portugal, developed two hydrogel supports made of polyvinyl alcohol (PVA) and gelatin, both containing iron oxide nanoparticles. Cells were then cultured on the hydrogels and exposed to a low-intensity magnetic field for 24 hours.

The cells on the PVA hydrogel produced less VEGF-A after the magnetic treatment. But the cells on the gelatin hydrogel produced more. Subsequent lab tests showed that these VEGF-A-rich extracts improved the ability of human vascular endothelial cells to sprout into branching blood vessel networks.

Endothelial cells were then placed onto a culture dish with a gap separating them. The conditioned media from magnet-treated mesenchymal stromal cells

from the gelatin hydrogel was added to the endothelial cells, which then moved to close the gap between them in 20 hours. This was significantly faster than the 30 hours they needed when they had not received magnetic treatment. Placing a magnet directly below the dish triggered the mesenchymal stromal cells to close the gap even faster, in just four hours.

More work is needed to understand what happens at the molecular level when a magnetic field is applied to the cells. But the researchers say gelatin hydrogels containing iron oxide nanoparticles and mesenchymal stromal cells could one day be applied to damaged blood vessels and then exposed to a short magnetic treatment to heal them.

The team suggests that magnet-treated cells on PVA, which produce less of the growth factor, could be used to slow down blood vessel growth to limit the expansion of cancer cells.

Credit: 123rf | shottythefirst

# AU NATUREL APPROACHES FOR HEALTHCARE AND BIODIESEL PRODUCTION

Researchers in Malaysia are using the chemistry of natural products for sustainable health and energy solutions.

Scientists at Universiti Malaysia Sarawak (UNIMAS) are investigating applications for natural and sustainable resources in the health and energy sectors. Teams are looking for ways to exploit the therapeutic potential of black pepper and to use the catalytic properties of ginger leaves for biodiesel production.

At UNIMAS's Faculty of Resource Science and Technology, Suk Fun Chin and her team have found a way to use



Credit: 123rf | galitskaya

modified starch nanoparticles to carry and slowly release piperine – the compound responsible for the spicy sting of black pepper – in the human body.

Research suggests that piperine has various therapeutic properties, including as an anti-depressant, an anti-inflammatory and anti-cancer agent, in addition to reducing fever and modulating the immune system. The problem is that it does not dissolve well in fluids and so cannot be

effectively absorbed and used by the body.

To solve this problem, Chin and her colleagues modified starch using an acetylation reaction to form starch acetate. This was then slowly precipitated in a solution of ethanol to form starch acetate nanoparticles.

The team found they could load piperine onto the starch acetate nanoparticles better than onto non-modified starch nanoparticles. Piperine was also released by starch acetate at a slower rate, over 24 hours, compared with non-modified starch nanoparticles, which released the compound over 16 hours.

“We think there is potential for using starch acetate nanoparticles loaded with piperine as a food supplement for the compound's health-related properties,” says Chin. The findings were published in the journal *Starch*.

In a nearby lab at the department of chemical engineering and energy sustainability, Mohammad Omar Abdullah and his colleagues have made solid catalysts for biodiesel production using waste ginger leaves.

The production and use of biodiesel have increased significantly in recent years. The production process involves converting oils and fats into fatty acid methyl ester, the predominant compound in biodiesel. Currently, the catalysts used in this chemical reaction are in the same phase as their reactants; in this case the oil and catalysts are both in liquid form. But it is expensive to separate the catalysts afterwards for reuse.

Abdullah and his team found a way to

use a heterogeneous, and thus separable and reusable, catalyst made from waste ginger leaves. They used different approaches to activate the ginger leaf catalysts and tested a variety of reaction times. They also analysed the process's energy input and output, and whether it was economical.

Of the approaches tested, one produced the highest yield of biodiesel, but it was not the most energy- or cost-efficient.

“Catalysts derived from agricultural



Credit: 123rf | splinex

waste are biodegradable and non-toxic,” says Abdullah. “More efficient processes for the use of waste ginger leaves as catalysts for biodiesel production could reduce the cost of biodiesel and make it more sustainable.”

Abdullah says further research is needed, but the study, published in the journal *Renewable Energy*, is a step in the right direction.

Credit: 123rf | kariphoto

# LESSONS FROM THE DEAD

**Whale and dolphin post-mortem imaging could breathe new life into marine conservation.**

Researchers at City University of Hong Kong have developed a new, non-invasive imaging approach to examine the remains of beached marine mammals, like whales and dolphins. The approach, called virtopsy, was described in the journal *Frontiers in Marine Science* and can be used to determine the cause of death. It can also gather useful information about the animal before it died, such as its general health, as well as if it suffered human impacts, such as vessel collision or marine pollution.

These findings could help governmental agencies and stakeholders across the world implement more effective marine conservation policies to protect vulnerable marine mammals.

Virtopsy uses modern imaging techniques to examine dead marine mammal remains. It is performed before conventional necropsy, the animal equivalent of human body-opening autopsies, or can even replace it in some cases.

“Virtopsy appears to be more accurate, time-saving and non-invasive compared to conventional necropsy, with less risk of

disease contraction for veterinarians and human rescuers,” says CityU radiological clinician Brian Chin-wing Kot.

In Hong Kong, marine mammal remains are often found badly decomposed on beaches, making conventional necropsies very difficult. Virtopsies provide an effective alternative to examine external and internal structures.

Kot’s team has carried out virtopsies on beached marine animal carcasses since 2014. The Cetacean Virtopsy-driven Stranding Response Programme is conducted in collaboration with the Hong Kong Agriculture, Fisheries and Conservation Department, Ocean Park Corporation, and Ocean Park Conservation Foundation Hong Kong.

Kot and his team have performed virtopsies on more than 200 beached marine mammals using post-mortem computed tomography (PMCT) and post-mortem magnetic resonance imaging (PMMRI). The work shows that PMCT identifies bone lesions, foreign bodies, pathological gas formation and organ trauma better than conventional necropsy. PMMRI is

better at identifying soft tissue injury, organ trauma and non-traumatic pathology.

The team also found that PMMRI provides more information on decomposed brains than PMCT. Additionally, it should be used in conjunction with PMCT to detect soft tissue lesions and brain pathologies, as PMMRI alone is more prone to showing unwanted artefacts from gas and foreign bodies.

“Our study is a valuable reference for other stranding response programmes worldwide that are interested in integrating virtopsy or other modern diagnostic modalities into their routine workflow,” says Kot. “We hope our research helps humans realise a ‘One Ocean, One Health’ ideal,” a concept that promotes the understanding that human, animal and environmental well-being are interconnected.

The team is now expanding its work by partnering with governmental organizations and academic institutions in mainland China, Japan, Taiwan, Thailand, New Zealand, Switzerland, Costa Rica and the US for cetacean and sea turtle stranding investigations worldwide.



Credit: City University of Hong Kong

The team uses modern imaging techniques to examine dead marine mammal remains.



Credit: City University of Hong Kong



Aquatic Animal Virtopsy Lab



To understand resolution of singularities... look at how to un-crush a crushed can.

# COVID-19: CHANGING HOW RESEARCHERS DO MATHEMATICS

Mathematician Yukari Ito was excited at first to work from home. There was no need to commute to her office at the Kavli Institute for the Physics and Mathematics of the Universe, where she is professor, and she could attend seminars by mathematicians around the world from her living room. But there are also challenges, so she hopes some things will go back to the way they used to be.

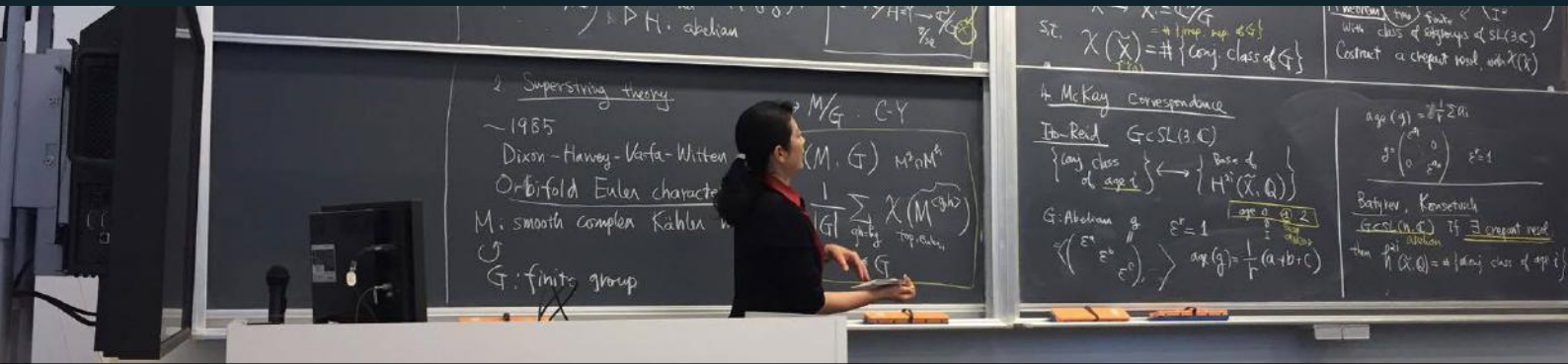
**Q: What has been the biggest change for you since the pandemic began?**

**A:** Everything going online was big. Many researchers had never used anything like Zoom. Before, research meetings meant going to different locations. That disappeared. Then mathematicians, mainly in Europe and the US, began holding meetings online.

At first I was excited, because I could listen to talks by mathematicians overseas working in areas close to my field, but with the time difference it meant I had to be awake in the middle of the night, and that would make me so tired the next day. Maybe if I were a student I would be able to stay up all night, but I still needed to get up at 6am the next morning to make my son's lunch, because children were still going to school.

*Mathematics is the oldest fundamental science. While it has changed and evolved over the centuries, the main concept remains to look for patterns, formulate mathematical explanations for those patterns, and then find proof that an explanation is true or false.*

Credit (all images): Kavli IPMU



**Q: Could you briefly introduce your research area?**

**A:** I work in algebraic geometry, particularly research about singularities. Imagine you have a sheet of paper. When you fold it, you get sharp points in certain places. These are singular points. I study resolution of singularities, which is thinking about how to eliminate these singular points.

*According to Ito, the real world is filled with singularities. Anything bent or curved is a singularity. MRI scans are programmed to look for singularities, which is why they manage to identify tumours that appear on what should be a smooth surface.*

*To understand resolution of singularities, Ito says the easiest two-dimensional example is looking at how to un-crush a crushed can of juice that has been twisted around its middle point.*

**A:** The can looks like two cones placed on top of each other so that they connect

at the sharpest point. This is your singular point. What happens when the point is eliminated? You will end up with the original cylinder-shaped can, and your point, where the can was twisted, has turned back into a circle. This is a resolution of singularities and the circle is called an exceptional set.

When there is a connection between a finite group that made the singularity, it's called a McKay correspondence. McKay correspondences in two dimensions are very well known, but I've been researching McKay correspondences in three dimensions since I was in graduate school.

*Exactly why mathematicians study singularities depends on who you ask. Ito says she and many others study them simply because they want to know what singularities are capable of. But there are also many other mathematicians who study singularities because they can help simplify otherwise complicated theoretical problems, making it easier to identify solutions. Nevertheless, mathematics has given humans significant insight and ability to predict nature, and any*

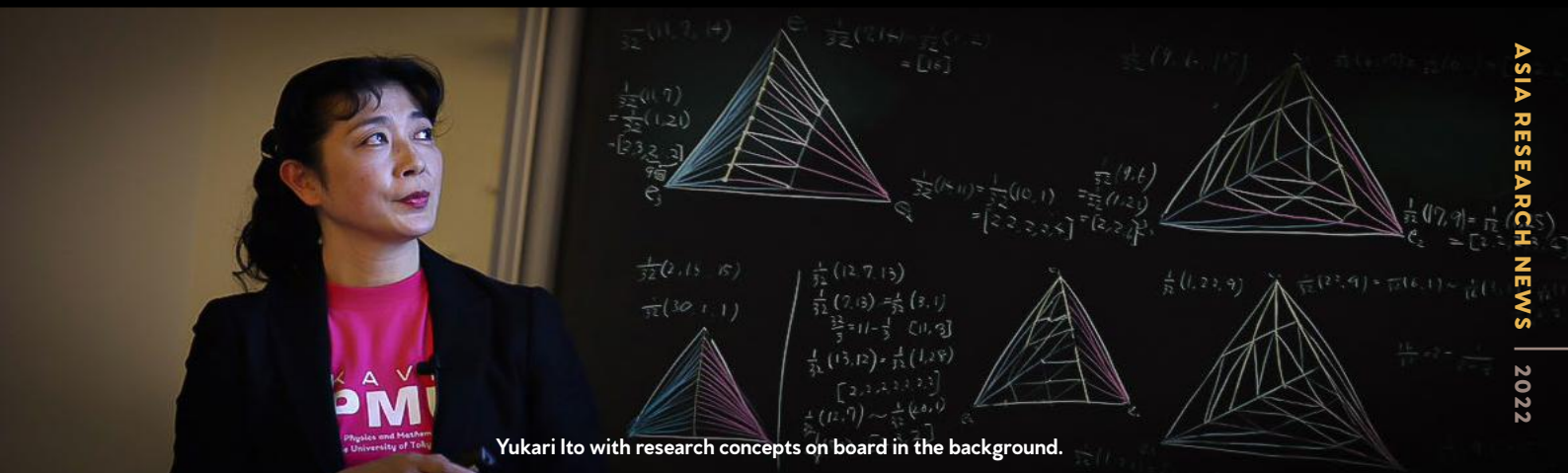
*practical applications are usually discovered well after the mathematics has been established.*

*How new mathematical themes of research are discovered, Ito says, can be influenced by trends in scientific research outside of mathematics. For her, it was the developments physicists were making in an area called mirror symmetry: an important relation between two spaces referred to as a "mirror pair" in superstring theory.*

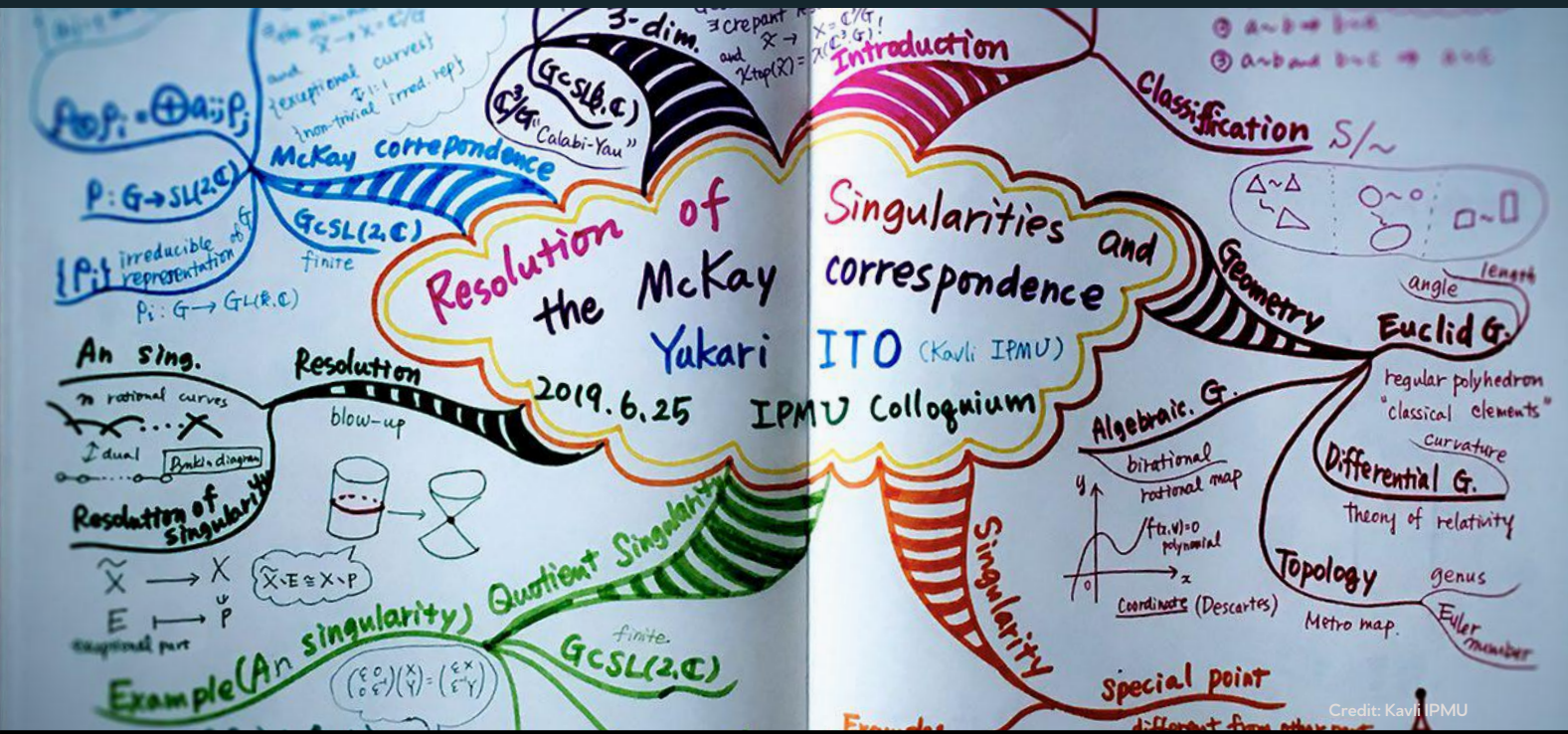
**Q: Why did you decide to study three dimensions?**

**A:** When I was a graduate student, not many people were working on three-dimensional singular points.

When mirror symmetry became a hot topic in physics, mathematicians looked at it and thought it looked similar to what they had seen with two-dimensional singular points. I was studying at the University of Tokyo at the same time as Kenji Fukuya, who would later go on to become a world leader in mirror sym-



Yukari Ito with research concepts on board in the background.



Yukari Ito's mind map on the concepts.

metry research. I remember attending a seminar by a visiting researcher who had come to talk about strange duality, which is a toy model of mirror symmetry, and the two-dimensional singularities connected to it. I thought: This is interesting. I wonder if anyone has looked into three dimensions.

I asked my supervisor and he said no one had and it could be an interesting path to pursue.

Today, everyone knows there are resolutions to three-dimensional singularities. But back then, no one did. So in a way, I'm grateful that I have been able to contribute a little bit to this field.

The great thing is that minimal reso-

lution is unique in two dimensions, but in three dimensions, there are many choices of resolutions. You can say that you've found one, but you don't know if there are more. You might find a more elegant resolution. So research into three dimensional resolution of singularities is by no means near completion.

A lot of mathematics from different fields is involved, and sometimes even physicists become involved, which means I have been able to meet and work with so many different people. Every two years, I help host a big meeting with different researchers to discuss progress and new themes. There is so much going on.

**Q: What has changed in your research since the pandemic began?**

**A:** Teaching students has been difficult. I couldn't say, "Let's try to solve this on the board," because we were all in our individual homes. I couldn't tell them to read this book from the library because everything was closed.

The online seminars have been good because you can watch mathematicians who can't easily make it to meetings because they are too ill or old.

Also researchers who can't secure funding to travel to overseas conferences were suddenly able to take part in our meetings because they were all online.



Researcher Yukari Ito at Kavli IPMU Women's Lunch

Credit: Kavli IPMU

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These lineages consist of a continuous line of puddle frog descendants from a common ancestor, which could be dated back to over 40 million years before present.

# THE EVOLUTIONARY HISTORY OF PUDDLE FROGS

A study on puddle frogs suggests underestimated biodiversity in Southeast Asia.

Earth's most biologically rich areas are facing unprecedented threats from human activities, impacting organisms and their habitats. Preserving their genetic diversity is therefore an important step towards conservation. Now, Universiti Malaysia Sarawak zoologist Indraneil Das and a team of international colleagues have examined the evolutionary relationships of the poorly understood puddle frog populations, which belongs to the genus *Occidozyga*. Their analyses have resulted in a more robust understanding of the evolutionary relationships between various species of the lineage.

Frogs of the *Occidozyga* genus have a wide distribution, from China to the islands of Southeast Asia. Puddle frogs are found in shallow water bodies, like ponds, swamps and slow-moving streams. They are often genetically diverse while exhibiting very subtle differences in their features, such as the extent of webbing on their feet, their dermal patterns, size and colouration. This makes it difficult to classify them based on their features alone.

Das and his team collected puddle frog samples from the Philippines and the Sundaland biodiversity region in Indonesia for over 20 years. They examined the features



A species similar to the familiar *Occidozyga laevis* is among at least 11 other distinct lineages across regions that include Borneo and the Philippines.

Another undescribed member of the genus, related to *Occidozyga rhacoda* can be found in the western hills of Sarawak in Malaysia.



*Occidozyga* tadpole, which is unusual amongst frog larvae in being carnivorous. Their mouth parts are adapted for taking in large arthropods.

of the frogs, conducted mitochondrial RNA gene sequencing, and compared their molecular information and fossil records relevant for calibration to geological events in the region in order to compile a phylogenetic tree that can map the evolutionary relationship between species belonging to the *Occidozyga* genus.

The analyses revealed extensive genetic diversity among puddle frog species, with at least 29 evolutionary lineages. These lineages consist of a continuous line of puddle frog descendants from a common ancestor, which could be dated back to over 40 million years before present.

While distinct lineages could be easily classified, the process of assigning species is a more complicated task that is part of ongoing work. The current result suggests that the diversity of these frogs has been largely underestimated.

The vastness of the *Occidozyga* genus makes them an excellent model organism for understanding other species with poorly-understood evolutionary relationships. "The recognition of lineages can have a profound effect on many aspects of biology, including the conservation and management of other endangered species," says Das.

# ELSI GRADUATE COURSE TACKLES FUNDAMENTAL QUESTIONS OF LIFE

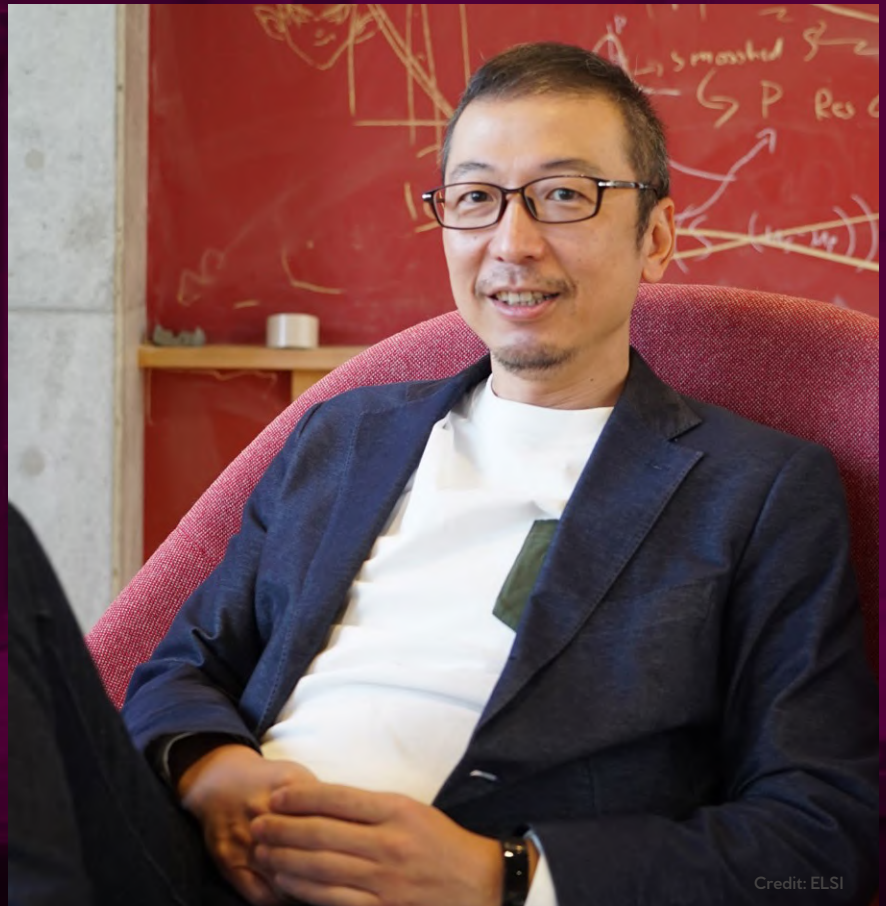
Credit: Tokyo Tech

**The Earth-Life Science Institute (ELSI) in Tokyo launches a new integrated graduate course exploring the origin and evolution of life and planets.**

How did Earth form and how did life emerge on our planet? What conditions are required for life to arise on other planets? The Earth-Life Science Institute (ELSI) at Tokyo Institute of Technology (Tokyo Tech) is launching a new graduate course to address these fundamental questions. The integrated five-year joint master-doctorate, starting in 2022, will be held in partnership with the Tokyo Tech's Department of Earth and Planetary Sciences and School of Life Science and Technology. The students will be based at ELSI under the mentorship of ELSI faculty.

## Training future leaders in earth and life sciences

ELSI is an independent research institute established in 2012. Its mission is to study the origin and evolution of planets and life, bringing together hundreds of world-leading scientists in fields ranging from astrophysics to geology to chemistry



Credit: ELSI

Tomoaki Matsuura is a professor of biotechnology and a course supervisor.

Credit: Tokyo Tech



and biology to tackle some of the most challenging questions in natural science. The launch of the new graduate course is the next milestone in ELSI's history, as it takes in students for the very first time.

"During the past decade, ELSI has grown into a fully formed and mature institution," says Tomoaki Matsuura, professor of biotechnology and one of the course supervisors. "We have created an ideal environment for top-level science and established a global network of researchers. Now it is time to use these resources to train the next generation of leaders in the field of earth and life sciences. This is a new and exciting challenge for ELSI."

### Developing breadth and depth in research

All students will be required to learn the basics of biology, chemistry and planetary sciences related to the origins of

life on Earth and the possibility of life on other planets. In addition, they can take classes organized by other departments to gain basic and advanced knowledge in a wide range of different disciplines, including courses at Tokyo Tech's Earth and Life Sciences department. The partnership is reciprocal and all students at Tokyo Tech can also take classes at ELSI.

As part of the graduate programme, the students will take courses on 'Collaboration with Industry' and 'Global Science



Credit: ELSI

Ryuhei Nakamura is a professor of electrochemistry and course faculty member.

Communication', to encourage them to develop practical skills and learn how to apply their knowledge in real-world situations.

The students will choose their individual research topics through discussion with their supervisor and other researchers inside and outside ELSI. Since the program runs for five years, the students will have the opportunity to gain both broad and specialist scientific knowledge, and to work on a very challenging project.

"ELSI is one of the few institutes in the world to offer a curriculum that specializes in the study of the origin of life on Earth and extra-terrestrial life," says Ryuhei Nakamura, professor of electrochemistry and one of the faculty members leading the course. "The institute offers a unique environment to study the new and emerging field of astrobiology; a discipline that is rapidly gaining recognition in the academic world."



Early career discussion

‘  
**The ability to think about scientific questions from new perspectives will be crucial to tackling many of the most complex challenges facing our planet today...**



Credit: ELSI

Breakout sessions encourage diverse and welcome new perspectives

### Uniquely interdisciplinary

ELSI has been specifically designed to encourage interdisciplinary research. The labs are located in the same building, encouraging scientists from different disciplines to pursue research collaborations, while also fostering informal discussions and chance encounters that can lead to new ideas and creative problem solving.

“The ability to think about scientific questions from new perspectives will be crucial to tackling many of the most complex challenges facing our planet today, such as combatting climate change, producing enough food, water and energy for a growing population, and preventing future pandemics,” says Nakamura. “By combining approaches

from different fields, ELSI’s scientists are finding new ways to confront major scientific problems.”

### An international environment

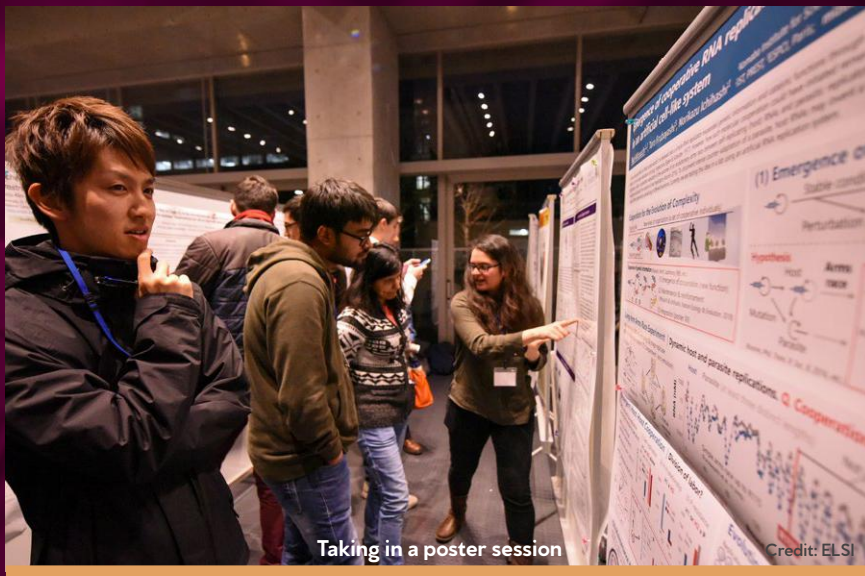
ELSI is home to a diverse community of faculty members and students from around the globe. Almost half the students are non-Japanese and the course is taught entirely in English. International students receive support with daily life in Japan, such as help with visa applications and housing. This unique setup allows ELSI students to feel at home in a new country and to build a strong network of friends and colleagues from all over the world.

“With our institute centrally located in

Tokyo, ELSI students will have the chance to explore the city and experience life in Japan, while also enjoying the benefits of a truly international working environment,” says Matsuura.

### World-leading faculty

The ELSI graduate course is supervised by eight faculty members, who are leading scientists in diverse fields, from astrobiology to biotechnology and electrochemistry. Students will be able to work closely with faculty members and top-level researchers from different groups. They are encouraged to pursue collaborations between fields and to embrace both theoretical and experimental research. They can also expect



Taking in a poster session

Credit: ELSI

to build a strong network of academic and industry connections to aid their future careers.

ELSI has adopted an open and flat research structure to avoid traditional university hierarchies, meaning students receive mentorship from experienced faculty members, but are given a high level of independence and autonomy to pursue their own research.

### Seeking highly motivated students

Graduates who are looking to apply should contact an ELSI professor directly to discuss their research interests. It is

important to find a common interest, so students should study their potential supervisors' research topics in advance. Students are free to contact multiple supervisors to decide what they want to work on.

The course is aimed at highly motivated students with a background in natural sciences who are looking to explore fundamental research questions related to the origins of Earth and life science in greater depth. Ambitious students who are keen to confront difficult scientific questions from an international and interdisciplinary perspective are encouraged to apply.

### Available funding

- ELSI will offer up to ten fully funded student fellowships each year on a competitive basis. Students will receive a stipend and tuition waiver.
- PhD students can apply for additional scholarships, such as from the Japan Society for the Promotion of Science (JSPS), the Japan Science and Technology Agency (JST) and industry.



Gathering for a symposium

Credit: N. Escanlar, ELSI

### How to apply

- Interested students should contact an ELSI professor via email: <https://graduate.elsi.jp/>.
- Students must prepare and submit an application for Tokyo Tech's International Graduate Program to the Admissions Division. The deadline for submission is October for courses starting the following April.
- Students will be required to take an entrance exam and attend an interview.



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# ANTIMICROBIAL RESISTANCE: THE SILENT PANDEMIC

The Asian Development Bank partnered with global institutions to examine efforts to curb one of humanity's most significant global health threats.

## Did you know?

**Antibiotic resistance happens when bacteria adapt to avoid destruction by antibiotics. Antimicrobial resistance is a much broader term that encompasses bacteria, viruses, fungi and parasites, and the cornucopia of drugs used to combat the infections they cause.**

The COVID-19 pandemic has caused a staggering number of deaths and illnesses, and an immense economic burden worldwide. But the awareness of the importance of infection prevention and control it has created, and the rapid global response it triggered, could be a blessing in disguise for the war against a more insidious pandemic that has been around for much longer.

In 2019, the World Health Organization declared antimicrobial resistance (AMR) as one of the top ten global public health threats facing humanity. Many bacteria, viruses, parasites and fungi have adapted over time to develop resistances to some of the life-saving antimicrobial drugs discovered since the early 20th century. This natural process of adaptation has been accelerated by the misuse and overuse of these drugs. Infections by drug-resistant microbes were predicted to cause 700,000 deaths a year but the actual number may be much higher based on a recent study (see next story). Scientists predict that this number will rise to 10 million deaths every year by 2050, with a global economic loss of US\$100 trillion, if no action is taken.

On December 7, 2021, a webinar on this issue was hosted by the Asian Development Bank Southeast Asia Development Solutions (SEAD), the International Vaccine Institute, Institut Pasteur Korea,

the International Centre for Antimicrobial Resistance Solutions (ICARS), and the Embassy of Denmark in Korea. Titled “[Curbing the invisible pandemic: Effective solutions to collectively combat antimicrobial resistance](#)”, the webinar brought together a large panel of experts to highlight the potential solutions and national action plans being developed to tackle this global problem.

## One globe, one health

“In order to solve the issue of AMR, a joint initiative is required that incorporates not only humans, but also animals, food and the environment; the so-called One Health approach,” said Eun A Her, member of the Korean National Assembly Science and Technology Information Broadcasting and Communications Committee.

One Health is a holistic and multi-sectoral approach for combating AMR by designing and implementing programmes, policies, legislation and research that recognize the interconnectivity of human, animal and environmental health.

ICARS was established in Denmark in November 2021 to apply this One Health approach to research that tests context-specific solutions for AMR in low- and middle-income settings.

“Low- and middle-income countries will



Credit: 123rf | drmicrobe

It is estimated that one million children die every year of pneumococcal disease, caused by the *Streptococcus pneumoniae* bacteria seen here.

be severely affected by AMR, as these are places where there is less access to clean water, sufficient sanitation and hygiene, as well as affordable medicines and vaccines,” explained Einar Jensen, an agricultural scientist and Denmark’s ambassador to Korea.

AMR is highly complex, as it does not respect geographic or human-animal-environment boundaries, explained Robert Skov, ICARS’s scientific director. Complicating the issue further, as countries become more developed, they inevitably use more antibiotics, which exacerbates the problem. On the other hand, the lack of access to antibiotics in less developed countries leads to more deaths than those caused by infections with drug-resistant bacteria, he said.

“So what needs to be done? We definitely need new antibiotics and new vaccines,” said Skov. He adds, however, that we also need to protect what we already have by developing strategies for the rational use of antimicrobial drugs, as well as for infection prevention and control, and biosecurity.

### The roles of vaccines and new drugs

AMR is a high research priority for the International Vaccine Institute (IVI). Antimicrobial drug use drops when vaccinat-

ed people are protected against infectious diseases. This happens by directly reducing the incidence of disease, but also by indirectly reducing the misuse of antibiotics that is often seen in connection with viral infections, explained Marianne Holm, IVI’s head of epidemiology and public health research.

Currently, there are very few licensed vaccines that target priority and potentially drug-resistant pathogens. There is also insufficient rollout of the few vaccines that do exist, said Holm. So it’s important to make better use of the existing vaccines that target the *Streptococcus pneumoniae* (which causes sepsis, meningitis and pneumonia) and *Salmonella enterica* serotype Typhi bacteria (which causes typhoid fever), and the *Haemophilus influenzae* type B virus (which causes influenza).

Evidence already demonstrates the impacts of these vaccines in reducing AMR diseases. In South Africa, the incidence of antibiotic-resistant invasive pneumococcal disease in children under the age of two dropped significantly after the introduction of pneumococcal conjugate vaccines in 2009 and 2011. In Pakistan, the typhoid conjugate vaccine was key to defeating an outbreak of a very drug-resistant bacterial strain in 2016. “This is a really promising success story,” said Holm. “Unfortunately, the rollout of typhoid vaccines is still limited.”

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**Infections by drug-resistant microbes is predicted to reach 10 million deaths every year by 2050, if no action is taken.**



Credit: 123rf | royaltystockphoto

According to the WHO, people infected with methicillin-resistant *Staphylococcus aureus* (MRSA) are 64% more likely to die than those infected with the drug-sensitive kind.

### Did you know?

**Conjugate vaccines incorporate two components linked together in order to trigger a stronger immune response against a microbe.**

**Did you know?**

**Gram stains are used to classify some bacteria into gram-positive or -negative, according to the physical properties of their cell walls and depending on whether they pick up the stain.**

The IVI is working on improving access to existing vaccines while at the same time developing new ones, including against tuberculosis, gonococcal disease and other intestinal infections.

At the Institut Pasteur Korea, researchers are also investigating bacterial physiology and resistance mechanisms to identify new molecules in bacteria and the drugs that can be used to target them. The institute has eight ongoing projects target-

country's ministries were not working together to combat AMR, explained Nithima Sumpradit, from Thailand's Ministry of Public Health. But since the plan's implementation in 2017, the health, agriculture and environment ministries have jointly developed an integrated AMR surveillance system using the One Health approach. Further, many antibiotics have been classified as prescription drugs and work is on-going to reduce the unnecessary use of antibiotics in outpatient practices for treating upper respiratory infections, acute diarrhoea and wounds. Thailand has also prohibited the use of antibiotics as a growth promoter in animals and has regulated their use in feeds.

"Thailand set out very ambitious goals at the beginning, but we think that, as long as they are measurable, they can advance our action beyond expectation," said Sumpradit.

Country ownership is critical for the success of action plans against AMR, added Satyajit Sarkar, a research scientist at the International Vaccine Institute. He emphasized the importance of using existing data at national, regional and global levels to inform the policy decisions that are needed to combat AMR.

In a world working to end the COVID-19 pandemic and prevent the emergence of new ones, "words should be supported by investments in interventions against AMR," concluded Eduardo Banzon, principal health specialist at the Southeast Asia Department of the Asian Development Bank.

The world is at a tipping point. The painful lessons learned during the past two years must lead to joint global efforts towards developing actionable solutions to prevent some of the most challenging health and environmental crises that our species has ever faced.



Credit: Bartay/IDRC

**Thailand has exceeded its goal of reducing antimicrobial consumption in animals by 30%.**

ing various gram positive and negative bacteria, and they are working with local and international partners to develop new therapeutic agents against antimicrobial-resistant bacteria.

### **Establishing clear targets in national action plans**

At the country level, Thailand has been especially successful in developing and implementing their National Strategic Plan against AMR. Before the plan, the

# THE GLOBAL BURDEN OF BACTERIAL DRUG RESISTANCE

A recent study in *The Lancet* provides the most comprehensive understanding of this global health problem to-date.

Bacterial antimicrobial resistance (AMR) poses a huge global threat to human health, most significantly in sub-Saharan Africa and South Asia, according to a study published in *The Lancet* in January 2022.

Conducted by an international collaboration of researchers, the study found that 1.27 million deaths worldwide could have been prevented in 2019 if all drug-resistant bacterial infections were replaced by drug-susceptible ones. Estimates showed that sub-Saharan Africa and South Asia carried the highest burden of deaths attributable to bacterial AMR in 2019, while Australasia had the lowest.

The researchers who published *The Lancet* study estimated the burdens of bacterial AMR in 204 countries and territories in 2019 that were associated with 23 pathogens and 88 pathogen-drug combinations by using predictive statistical modelling on a wide array of data obtained from the scientific literature, hospitals, pharmaceutical companies, diagnostic laboratories, clinical trial data, and global and national surveillance networks and systems. Their modelling approach was able to include estimates for locations that did not have data.

They found that 1.5 million deaths from lower respiratory infections could have been prevented in 2019 if all drug-resistant

infections were replaced by no infections. They also identified six bacteria and seven pathogen-drug combinations as being responsible for a significantly large portion of AMR-associated deaths.

“Our estimates indicate that bacterial AMR is a health problem whose magnitude is at least as large as major diseases such as HIV and malaria, and potentially much larger,” write the researchers. “If left unchecked, the spread of AMR could make many bacterial pathogens much more lethal in the future than they are today.”

The researchers explain that high burdens of bacterial AMR occur as a result of two confounding factors: a high

**Bacterial antimicrobial resistance poses a huge global threat to human health.**



Credit: 123rf | beingbonny



Credit: 123rf | duybox



**Our estimates indicate that bacterial AMR is a health problem whose magnitude is at least as large as major diseases such as HIV and malaria, and potentially much larger.**



Credit: 123rf | eunika



Credit: 123rf | makasahphoto

**Estimates showed that sub-Saharan Africa and South Asia carried the highest burden of deaths attributable to bacterial AMR.**

prevalence of bacterial drug resistance and a high frequency of critical infections. Other drivers of high AMR burden in low- to middle-income countries include poor laboratory infrastructure, making it difficult to inform treatments; insufficient in-country regulations of antibiotics, leading to their inappropriate use; the presence of substandard or counterfeit antibiotics; and poor sanitation and hygiene.

The study found that AMR patterns varied widely geographically, with different pathogens and pathogen-drug

combinations dominant in different locations. The information could help policymakers devise context-specific responses. For example, limiting access to antibiotics in South Asia could prove helpful, as their overuse and misuse are expected to be a major driver of AMR burden in the region. In western sub-Saharan Africa, on the other hand, it might be useful to make second-line antibiotics more accessible. These are antibiotics that are prescribed when a first course of antibiotics doesn't work.

The study's findings highlight the importance of developing policies that specifically target certain pathogen-drug combinations through expanding infection prevention and control programmes, improving access to some antibiotics, and through vaccine and antibiotic development. The researchers emphasize that it should be a very high priority for global health policy makers to increase laboratory and data collection capacities with the aim of improving understanding of bacterial AMR.

# ASIA'S RACE TO OUTSMART ANTIMICROBIAL RESISTANCE

*Asia Research News* surveyed institutions in Asia to learn about their latest contributions to antimicrobial resistance research.

Credit: 123rf | efks

From investigating predator bacteria and studying organisms at the molecular level, to understanding host responses and looking for effective new drugs, scientists in Asia are making big strides.

## Korea

Working just south of Seoul, Soojin Jang is the group leader of Institut Pasteur Korea's Antibacterial Resistance Research Laboratory. She is leading her team's efforts to study bacterial physiology and resistance mechanisms. Their aim is to use this knowledge to develop new screening systems for identifying small molecules and natural compounds that can be used against drug-resistant organisms.

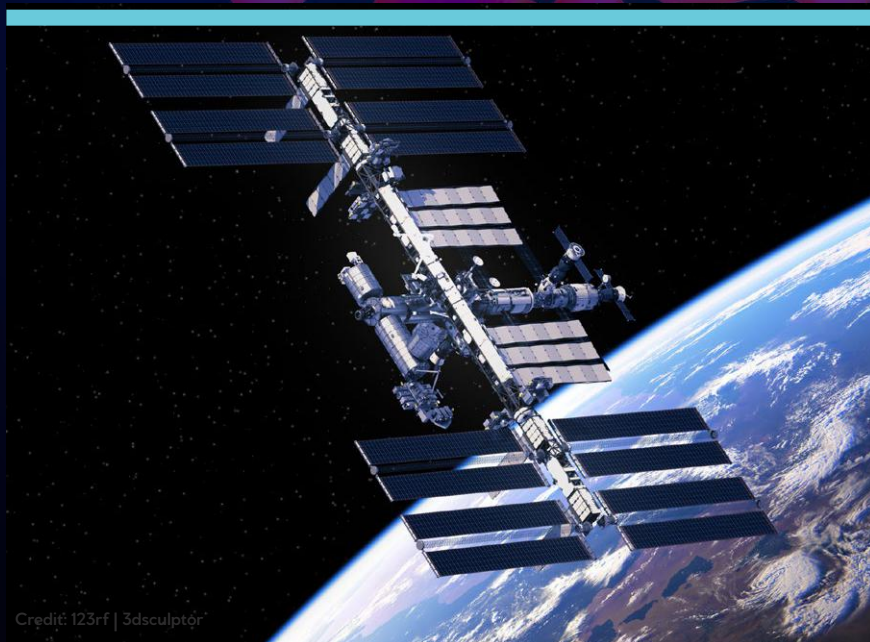
Further southeast, Robert Mitchell is studying a type of bacteria that destroys other organisms. A biological scientist at Ulsan National Institute of Science and Technology (UNIST) in Korea, he and his colleagues have found that these 'predatory bacteria' not only kill other pathogens, but can also remove their DNA, including their antibiotic resistance genes. In his most recent study, Mitchell found that the predatory bacterium *Bdellovibrio bacteriovorus* HD100 was active against two groups of antimicrobial resistant pathogens under simulated microgravity conditions. The findings illustrate its potential for treating biofilm-covered surfaces in spacecrafts. *Asia Research News* covered their [previous work](#) in 2017.

## Japan

At Kyoto University in Japan, structural biologist So Iwata has been using X-ray protein crystallography to investigate how specialized membrane channels, called transporters, remove antimicrobial drugs from inside bacterial cells, saving them from their deadly effects. "We found that these nanoscale molecular machines change their shapes to pump antibiotics out of the bacteria," he explains.

Osaka Metropolitan University dermatologist Toshiyuki Ozawa has been looking into photodynamic therapy. His team uses a light-sensitive substance which reacts with a certain wavelength of light to produce reactive oxygen that selectively kills malignant tumours and bacteria. Unlike antibiotics, the therapy does not produce drug resistant bacteria.

Bacteria, including drug-resistant ones, have been found growing as biofilms on some surfaces in the International Space Station.



Credit: 123rf | 3dsculptor

Credit: 123rf | drmicrobe



*Pseudomonas syringae* is one of the most common plant pathogens, with impacts on global crop production.

Credit: Creative Commons

## Nepal

At Kathmandu's Global Institute for Interdisciplinary Studies, Suraj Bhattarai, an InterAcademy Partnership (IAP) Young Physician Leader, has demonstrated the high burden of serious bacterial infections and multidrug-resistant bacteria on community and hospital deaths in low- and middle-income countries, including Nepal. His research highlights the importance of health-facility and community level surveillance of antimicrobial resistance.

## Hong Kong

Biomedical scientists Xin Deng and Jian Yan at City University of Hong Kong (CityU) have identified gene regulatory proteins, called transcription factors, that are involved in making the bacterium *Pseudomonas syringae* harmful against a wide variety of plants. In one of their most recent studies, they revealed how these transcription factors bind to genes in order to activate them. Their research could facilitate the development of new drugs against the bacterium.

Also at CityU, veterinary bacteriologist Sheng Chen has been investigating how a bacterial gene has evolved to resist tigecycline, a last-resort antibiotic. His research, which involved studying thousands of bacterial strains collected in China over a quarter of a century, suggests the gene may have originally come from a *Flavobacteriaceae* ancestor and was then transferred to other bacteria. He and his team hope that blocking the mechanism that facilitates the gene's transmission could lead to new treatment strategies.

## Singapore

Andrea Lay Hoon Kwa and her team at Duke-NUS Medical School/Singapore General Hospital, are investigating strategies for managing critically ill patients with difficult-to-treat infections. Using a technique they developed, ineffective antibiotics gain new potency when used as a combined therapy. Additionally, they are looking into optimal prescriptions and combining antibiotics with harmless, naturally occurring viruses that infect bacteria.

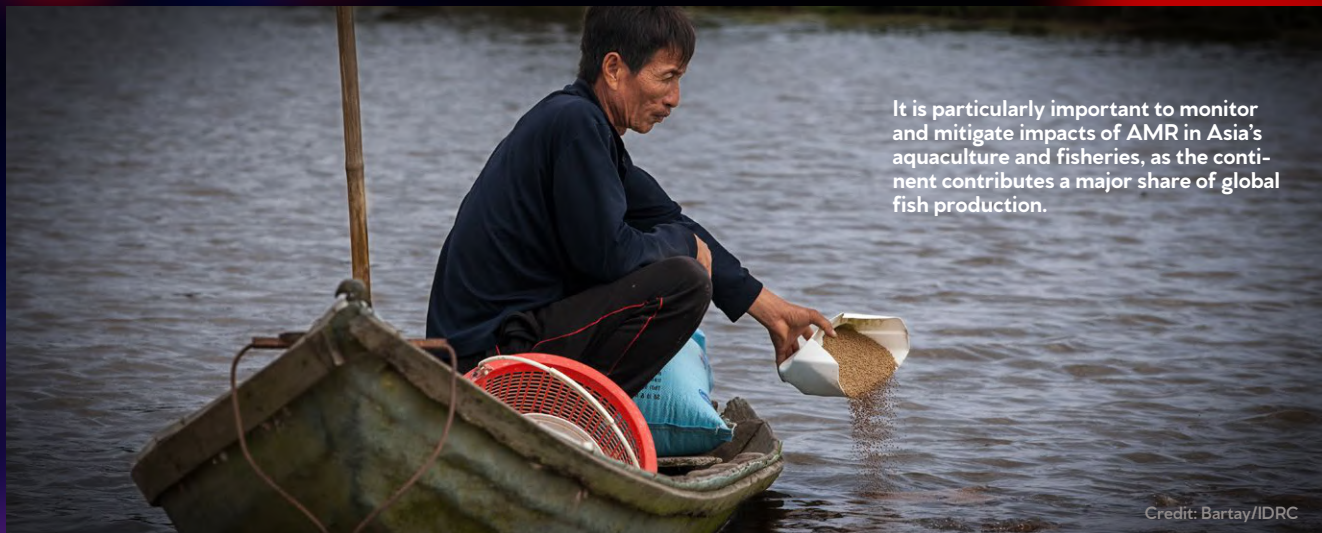
At the Agency for Science, Technology and Research (A\*STAR)'s Infectious Diseases Labs, scientists are looking for ways to develop strategies against treatable and antibiotic-resistant pathogens. The team at Pablo Bifani's Antimicrobial Resistance Lab, for example, are looking for special viruses, called bacteriophages, that can be used against antimicrobial resistant bacteria. Amit Singhal's Bacterial Immunopathology Lab is investigating the mechanisms behind the inflammatory responses caused by major infectious diseases in Southeast Asia, like tuberculosis and dengue. At the Antifungal Resistance Lab, Wang Yue is profiling and characterising the mutations that lead to resistance. He and his team hope their work will lead to the identification of new drug targets. Matthew Tay's research at the Antimicrobial Biologics Lab is focused on finding ways to develop antibodies that can be used as adjunct therapies against multidrug-resistant pathogens. Finally, Stefan Oehlers at the Bacterial Pathogenesis Lab is using infected zebrafish to rapidly test antibiotic toxicity and their bioavailability to bacteria.

Currently, there are no effective treatments against the dengue virus, which is transmitted by the *Aedes* mosquito seen here. In their quest to develop an anti-dengue drug, scientists are looking for molecular targets in the virus that are less likely to be affected by antimicrobial resistance.



Credit: i23rf | marcoulina

Credit: i23rf | parilov



It is particularly important to monitor and mitigate impacts of AMR in Asia's aquaculture and fisheries, as the continent contributes a major share of global fish production.

Credit: Bartay/IDRC

## FISH HEALTH TOO MALAYSIA, HONG KONG, THAILAND AND VIETNAM

Asia produces 90% of the world's aquaculture, providing an important source of nutrition and employment. Canada's International Development Research Centre in partnership with the UK Department of Health and Social Care's Global AMR Innovation Fund (GAMRIF) are supporting several projects in Asia aimed at addressing antimicrobial resistance in the aquaculture industry.

At Universiti Putra Malaysia, Natrah Fatin Bt Mohd Ikhsan is using a technology, called 'quorum quenching', that can stop bacteria communicating with each other. This enhances the host immunological responses to infection, thus reducing the need for antimicrobial drugs in shrimp aquaculture.

At City University of Hong Kong (CityU), Sophie St-Hilaire, Alicia An and colleagues are investigating ways to reduce bacterial and antibiotic levels in aquaculture environments, as these are known drivers of antimicro-

bial resistance. This includes improving filtration systems and coating materials to reduce antibiotic leaching for medicated feeds.

Ha Thanh Dong at Thailand's Asian Institute of Technology and Phan Thi Van and Nguyen Huu Nghia at Vietnam's Research Institute for Aquaculture No 1 are all investigating the use of ozone nanobubble injections in water to reduce bacterial load and modulate fish and shrimp immune systems, improving their survival when exposed to pathogens.

Vietnam is the world's largest producer of the freshwater catfish *Pangasius*, but large-scale losses due to bacterial diseases have resulted in widespread use of antibiotics and the development of AMR. Mags Crumlish at the University of Stirling's Institute of Aquaculture in the UK is leading a multidisciplinary project to develop innovative vaccines and delivery methods to reduce AMR development in this freshwater aquaculture sector.



Credit: Bartay/IDRC

Natrah Ikhsan is using quorum quenching to stop bacteria from communicating with each other.



Listen to IDRC's **Innovating Alternatives Podcast**, which follows researchers tackling AMR in livestock and aquaculture.



Credit: Bartay/IDRC

Scientists in Thailand and Vietnam are using ozone nanobubbles to improve fish survival in aquaculture.

Tell us about your research on antimicrobial resistance.  
[info@researchsea.com](mailto:info@researchsea.com) or Twitter [@ResearchSEA](https://twitter.com/ResearchSEA)  
 See also **Focus On: Experts for Media**

# PLACING SCIENCE OUTREACH CENTRE-STAGE IN JAPAN

**A team at Japan's Earth-Life Science Institute (ELSI), at Tokyo Institute of Technology (Tokyo Tech) is conducting evidence-based outreach to demonstrate why science communication training is so important, with an aim of encouraging other higher education and research institutions to follow its lead.**

Public and government responses to the global COVID-19 pandemic and climate change have highlighted why it is so crucially important for scientists and their institutions to become better communica-

of the important science communication traditions within ELSI and in Japan, while also ushering in the new.

A case in point: institutions across the country highly value their annual science

older audiences. Heenatigala believes this is important to improve science literacy and also inspire the next generation of scientists. Some of ELSI's public engagement activities are now hosting much younger audiences as a result of these efforts. [ELSI's Annual Public Lecture 2022](#) in January was held under the title of: "From Deep Earth to Deep Space", hosting talks by inner Earth expert Kei Hirose and planetary atmospheric scientist Yasuhito Sekine.

ELSI is so convinced in the importance of science outreach that it is launching a global science communication course in its new and upcoming five-year integrated graduate programme on origins of life studies. "A key thing universities in Japan need to look into is including formal science communication programmes in their curricula in order to generate a highly skilled outreach workforce," says Heenatigala. Currently, he explains, outreach is conducted in most Japanese institutions by administrative staff, who love science and its communication but are not typically trained in either of these fields. These dedicated employees often find it difficult to get institutional approval to improve their skills by attending science communication workshops, as institutions aren't conventionally accustomed to sending their staff out for training and conferences as they do for their scientific faculty. "Institutions need to encourage their staff to attend locally available training," says Heenatigala. To address this gap, ELSI's outreach team organizes science



Thilina Heenatigala, Director of Communications and lecturer

tors. Scientific research is paid for by the people and is ultimately for their benefit, yet people tend to exhibit the signs and symptoms of science scepticism if they do not understand the science and trust the researchers. Thilina Heenatigala (he/him) is director of communications and lecturer at Japan's Earth-Life Science Institute (ELSI). He is on a mission to standardize outreach programmes within Japanese science institutions and to give science communication the credit it deserves.

He is doing this by holding onto some

symposiums. ELSI's 9th annual symposium in 2021 and 10th symposium in January 2022 both dedicated parts of their programs to outreach and science communication. This is the first time for these symposiums not to be fully dedicated to a scientific topic.

Heenatigala and his team at ELSI's outreach and science communication office have also been organizing promotional campaigns to encourage school students to attend some of the institute's public lectures, which are typically attended by

Background Credit: ELSI | abanoo42 and ELSI

communication training sessions for scientists and outreach practitioners at the institution and in other parts of Japan.

In recent years, ELSI has also become very innovative in its science communication approach. Its science-art programme annually hosts an artist on the institution's premises for a period of three to six months, with the aim of opening the

ELSI's outreach office is also involved in publishing press releases about the science that is going on within the institution. This does not come without its challenges. ELSI research is uniquely interdisciplinary in nature, involving scientists from a wide range of backgrounds, such as biology, chemistry and astronomy. At the same time, people are often interested in

methods of data collection and analysis aimed to help outreach practitioners, researchers and policymakers measure and understand the impact of science outreach activities.

Heenatigala hopes to see more formal science communication education in Japan and the wider Asia region, with more training opportunities for scientists and



Conceptual artwork in the theme of 'the Origins of Life' by Padi Faraji.

minds of scientists and artists to each other's different ways of thinking.

Japan-based Iranian artist Padi Faraji, who participated in the project in 2021, explains that working with scientists gave her a unique perspective on the universe, while the researchers she collaborated with got the opportunity to understand how the artistic approach might look at fact-based studies by thinking about the colours, smells, and other senses they involve. The collaboration produced a conceptual artwork with the theme "Origins of Life" that explores how Earth and life on it formed and evolved.

origin of life science. "It is a challenge for outreach to strike a balance in covering all these areas while also making sure that the institution's studies do not get sensationalized by the media," says Heenatigala.

There is evidence that they have been successful in these efforts. In 2020, for example, more than 460 stories were published in local and international media about ELSI research activities.

ELSI's outreach office is taking evidence-based evaluation of its work very seriously. Heenatigala and his team have designed the ELSI Science Outreach Evaluation Framework, which includes several

outreach practitioners already involved in the vocation. "It's important for institutions to realize that science outreach requires an entirely different set of skills from science administration," he says. Finally, he hopes every science institution on the continent ultimately develops an outreach and communication strategy. "Many universities have their vision and mission documents, but they don't always address communication and outreach and how these can be successful. These are lacking and we should look into them."



Credit: ELSI

Participants at the annual Japan SciComm Forum

# ATMOSPHERIC LINK BETWEEN NORTHERN WILDFIRES AND HEATWAVES

**A recent summertime climate pattern could be driving co-occurring European heatwaves and large-scale wildfires over Siberia, Canada and Alaska.**

A unique post-2002 summer atmospheric circulation pattern could be behind recent summertime Arctic and sub-polar wildfires co-occurring with heatwaves in Europe. The findings, by an international team of researchers, including Hokkaido University atmospheric scientist, Teppei J. Yasunari, were published in the journal *Environmental Research Letters*.

Wildfires lead to extensive air pollution, impacting health and the environment. Much of this pollution is in the form of inhalable particulate matter (aerosols) with a diameter of 2.5 micrometres or less (PM2.5).

Scientists in Japan, Korea and the US wanted to better understand the inter-relationships between climate patterns, wildfires and air pollution over Arctic regions in recent years.

The researchers analysed NASA atmospheric, aerosol and satellite wildfire data, some of which extends back to 1980.

They found that PM2.5 levels tended to be particularly high over the Arctic during the summer months between 2003 and 2017. They were able to link these high PM2.5 levels with higher organic carbon aerosol concentrations caused by recent active wildfires in Siberia and sub-polar North America.

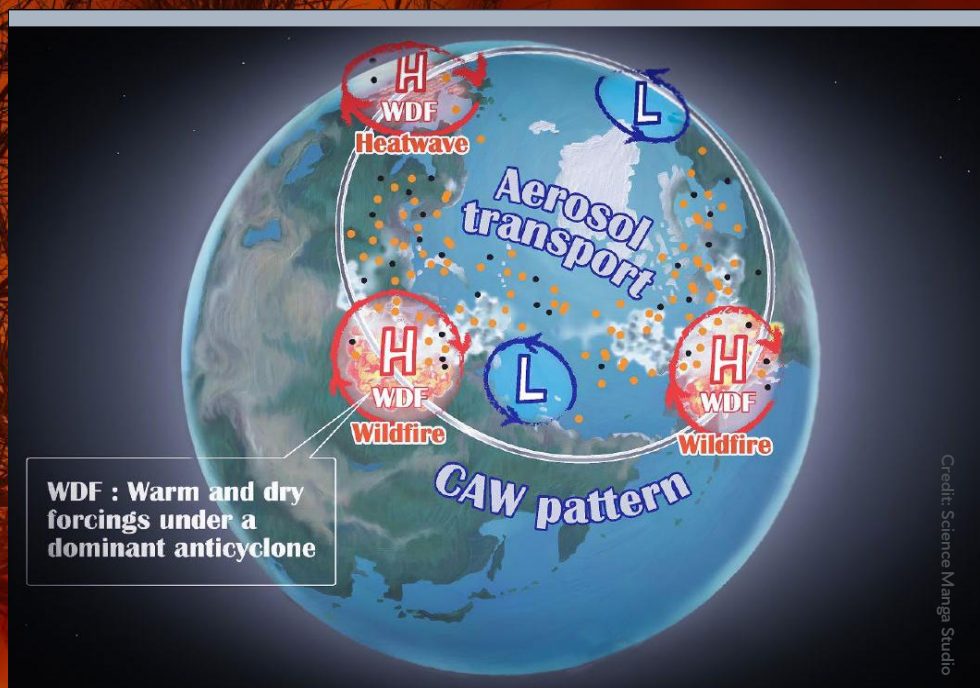
They also found that these high PM2.5 levels were associated with a clockwise atmospheric circulation pattern represented by dominant high-pressure systems over Europe, Siberia and subpolar

North America. They named the pattern the circum-Arctic wave (CAW). A similar clockwise atmospheric pattern, causing warmer conditions, was also observed over Western Europe, central Siberia, Alaska and Canada in late June 2019. Interestingly, the team also found that the summertime CAW pattern only became prominent after 2002.

“We concluded that extremely warm and dry conditions in recent summer years as a result of the CAW pattern over Europe, Siberia and sub-polar North America drove co-occurrences of summertime wildfires and heatwaves. The

wildfires contributed to exceptionally high PM2.5 levels in the Arctic,” says Yasunari.

The study expands conventional knowledge of the connections between weather conditions, wildfire-induced air pollution and climate patterns. Further research will focus on understanding how the CAW pattern is triggered, develops and persists under present and future climate conditions. Improving summer climate projections associated with wildfires and heatwaves will help people living in and around the Arctic develop effective measures for responding to large-scale heatwaves and wildfires.



The characteristics of the discovered circum-Arctic wave (CAW) pattern, inducing warming and dry conditions, can cause co-occurrences of European heatwaves and sub-polar North American wildfires.

Credit: 123rf | photochicken

# SPINNING ELECTRICITY UNDER THE SKY

**A magnetic hybrid system generates electricity day and night with radiative cooling and solar heating.**

A new device harvests two types of energy during the daytime, making it cool on one end and hot on the other, to generate electricity around the clock. With further improvements, the device could be used in off-grid Internet-of-things sensors. The details were published in the journal *Science and Technology of Advanced Materials*.

Scientists have known for at least 200 years that electricity can be generated from a temperature gradient, a phenomenon called thermoelectric generation. Recently, researchers have developed thermoelectric conversion technologies by changing material parameters and introducing new principles. For example, researchers have found that magnetic materials can generate thermoelectric voltage by inducing a flow of electron spins along a temperature gradient, called the spin Seebeck effect, and that increasing a device's length perpendicular to the gradient boosts voltage. Scientists would like to fabricate more efficient, thin ther-

moelectric devices based on the spin Seebeck effect. However, the thinner the device, the more difficult it is to maintain a temperature gradient between its top and bottom.

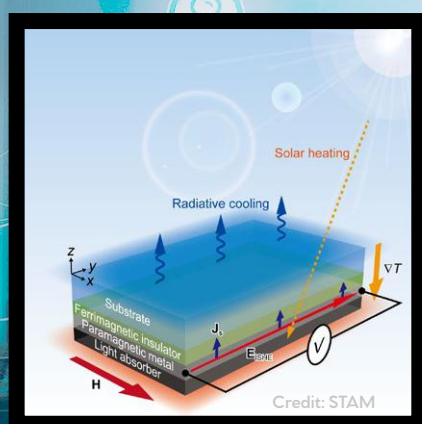
Satoshi Ishii and Ken-ichi Uchida of Japan's National Institute for Materials Science and colleagues have solved this problem by making a magnetic hybrid system that continuously cools at the top and absorbs heat from the sun at the bottom. In this way, the device harvests two types of energy. Radiative cooling occurs at the top, as heat is lost from a material in the form of infrared radiation, while solar radiation is absorbed at the bottom.

"It is really important to take full advantage of renewable energy in order to achieve a more sustainable society," explains Ishii. "Daytime radiative cooling and solar heating have both been used to improve a variety of thermoelectric applications. Our device uses both types of energy simultaneously to generate a thermoelectric voltage."

of gadolinium gallium garnet. This layer is transparent to sunlight and emits thermal radiation to the universe, getting cooler. Sunlight passes through the following ferrimagnetic layer made of yttrium iron garnet. This layer is also transparent, so light continues to travel down into the bottom two light-absorbing layers, made of paramagnetic platinum and blackbody paint. The bottom section stays warm due to sunlight absorption. The spin current is generated in the ferrimagnetic layer owing to the temperature gradient between the top and bottom of the device and is converted to electric voltage in the paramagnetic platinum layer.

The device works best on clear days, as clouds reduce the achievable temperature gradient by blocking the emitted infrared radiation from passing through the atmosphere and reducing the solar heating.

While promising, the device's thermoelectric generation efficiency was still quite low. The team plans to boost its efficiency by improving the design, experimenting with different material combinations, and developing even more novel strategies for thermoelectric generation.



The device's top stays cool while the bottom remains warm by losing and absorbing heat, respectively.

## Here's how it works:

The device has four layers. The top layer is a paramagnetic insulator made

# TEN YEARS OF ELSI: EARTH, LIFE AND A NEW RESEARCH CULTURE IN JAPAN

Unlike most traditional Japanese universities, the Earth-Life Science Institute (ELSI) at Tokyo Institute of Technology has created a 'flat' and diverse research environment. On its ten-year anniversary, Outgoing Director Kei Hirose shares what is special about the institute and the secret behind its successful management.

**Q: How did ELSI's theme, the Origin of the Earth and Life, come about?**

**A:** ELSI was born from the Department of Earth and Planetary Sciences at Tokyo Institute of Technology. Since we were setting up a new research institute, we wanted a big theme for researchers to study under. The one we all agreed on was the origin of the Earth.

The birth of Planet Earth and the sequence of events that created the magma ocean and the core happened all around the same time. So we decided to focus on that part first. Since we believe that life was probably born not so far from when the Earth was formed, we included that in the theme. So we had a research target on the formation of the Earth, its early stages and the birth of life.

**Q: What have they discovered at ELSI so far?**

**A:** We have a deeper understanding of what happened in the magma ocean when the Earth was formed. The surface layer of the Earth today is basically made of rocks, but there was a time when all the rocks were melted and the entire Earth was covered with magma. This is called the magma ocean state.

Thanks to this state, the Earth was divided into three parts: the atmosphere/sea, the mantle (rock) and the core (metal).

We were able to further clarify the role of the magma ocean as a starting point of various planets, including Earth and Venus, and possibly Mars.

We are also interested in how organisms were born on Earth, which was originally uninhabitable and had no life at all. For example, there is only 0.04 atmospheric pressure (atm) of carbon dioxide on Earth now, compared to what is believed to have been about 100 atm of carbon dioxide back then. Carbon dioxide is very oxidative, but living organisms, like humans, are made up of organic matter, which is more reductive. Most carbon back then was

Early Earth had 100 atm of carbon dioxide compared to only 0.04 atm today.

in the form of carbon dioxide, yet life somehow arose. It was a very big challenge to understand how a carbon dioxide-dominant environment managed to create a more reductive carbon, like that found in the human body.

What we found is that the large amounts of atmospheric carbon dioxide reacted with an existing flow of electricity and hot water spouts emerging from the Earth's surface, converting it into carbon

monoxide. This was then further reduced to make amino acids, which are the ingredients of organisms.

**Q: What makes ELSI attractive for researchers?**

**A:** It is a very international, open and 'flat' place. In the traditional university system, the professor is sitting at the top, followed by associate professors, assistant professors and students at the bottom. This pyramid structure exists everywhere in the world. ELSI is not such a place at all.

For example, a postdoc working on one research topic could be collaborating with a professor who has a completely different research project. I call that a flat environment. Normally, a postdoc works on what a professor tells them to do. At ELSI, that's not necessary at all. In short, postdocs can work freely here. I think that makes ELSI very attractive.

**Q: What is the secret behind ELSI's rich diversity?**

**A:** Japan lags behind when it comes to diversifying university environments. Universities often tackle this issue by welcoming international students, but that does not solve it. I believe that the most important thing in this case is to bring excellent researchers from abroad to Japan. ELSI has been most successful achieving that out of all the WPI centres\*.

Credit: Creative Commons



Credit: N. Escanlar, ELSI

The important thing is that ELSI remains the place that people want to come to. It means that ELSI is properly positioned within the flow of researchers and in something you could call an international circulation of intelligence.

Professor Kei Hirose

The reason why it has worked well at ELSI is that we had international staff recruiting international staff. For example, it doesn't work very well if I, a Japanese person, say, "Please come to Japan. It is a nice place." But when an American researcher at ELSI talks to another American researcher, it is incredibly effective.

fore. It was more like we made them work together. That was ELSI in the early stages.

In Japan, many organizations are vertically divided. A department of Earth and planetary sciences and a department of biology may be in the same building, but there is usually no communication whatsoever between them. Conducting joint research with people we had never even talked to was therefore our first big challenge. We were clueless in the first few years.

Eventually, more researchers joined and visitors from abroad came for short or long periods. There was a

constant flow of incoming and outgoing staff as ELSI's name became known internationally. It then became easier to invite international scientists. Simultaneously, collaborative work was carried out in a more natural way.

national circulation of intelligence. That is, if someone has just finished a doctorate degree in France, they might be looking to Europe and the United States as a next career destination. Now, ELSI is also included as one of their choices.

Also, it is important that ELSI creates many opportunities, including joint research proposals, in order to attract researchers from various places. Simply put, ELSI should always serve as a hub within the international research community.

**Q: With its 10th anniversary, ELSI will reach a turning point. Any comment for the future of ELSI?**

**A:** ELSI will finish receiving major support from the WPI\* this year and I will be passing on the director's baton. The next director, Professor Yasuhiro Sekine, is young and has a solid mindset. In the first ten years, we had our arms open for any research related to the origin of the Earth and life. In the second phase of ELSI, they are trying to sharpen the focus even more. We're looking forward to the next evolution of ELSI.

\*The World Premier International Research Center Initiative (WPI) was launched in 2007 by the Ministry of Education, Culture, Sports, Science and Technology. ELSI is one of the 14 WPI centres in Japan.



Director Kei Hirose with colleagues at ELSI

Of course, we need to make sure that the researcher who comes to Japan is happy so that they will stay. For example, if their child gets sick, ELSI staff will help take them to the doctor. We provide care and support for the researchers and their families on a daily basis.

**Q: What changed most in the last ten years?**

**A:** We started ELSI with Earth and planetary researchers specialised in the origin of life and by asking them to do joint research; something they had not done be-

**Q: What is important to remain internationally competitive?**

**A:** The important thing is that ELSI remains the place that people want to come to. It means that ELSI is properly positioned within the flow of researchers and in something you could call an inter-

An artist's impression of Mars four billion years ago

# THE DAWN OF EVOLUTION: ELSI'S QUEST FOR EXTRA-TERRESTRIAL LIFE

The Earth-Life Sciences Institute (ELSI) based at Tokyo Institute of Technology will reach a turning point this year. For the first time in its 10-year history, it will extend the scope of its initial research theme, "The Origins and Evolution of the Earth and Life", to include searching for evidence of extra-terrestrial life. ELSI's new director, Yasuhito Sekine, told *Asia Research News* what they hope to achieve in the next phase and how.

**Q: Tell us about ELSI in the past 10 years and its future.**

**A:** In the last 10 years, ELSI has developed the foundation for the "ELSI model", which fuses different fields of research in order to understand the origins of life as a consequence of the formation and evolution of Earth.

The ELSI model is not intended to describe the origins of life as a mere chemical reaction, but as a consequence of a series of interactions among life on Earth, from the formation of the solar system to the formation of the present biosphere and human sphere.

Since the origins of the solar system, there were some important turning points in the shaping of the Earth. If Earth had taken a different path, it would not have become the planet it is now, and life might not have been born or a completely different form of life might have come to be. The ELSI model shows the choices that were necessary for the Earth and life on it to form.

In the next 10 years, we will develop the ELSI model further, and want to

understand whether it can be also be applied to other planets and satellites of the solar system and other systems, and if life can occur elsewhere.

In considering the possibility of extra-terrestrial life, it is necessary to form organic cooperation with the Japan

**Q: Does this mean that ELSI will have a new theme?**

**A:** ELSI will shift its theme from "The Origins and Evolution of the Earth and Life" to "Universal Biology". With this new concept, we will unveil the possibility of

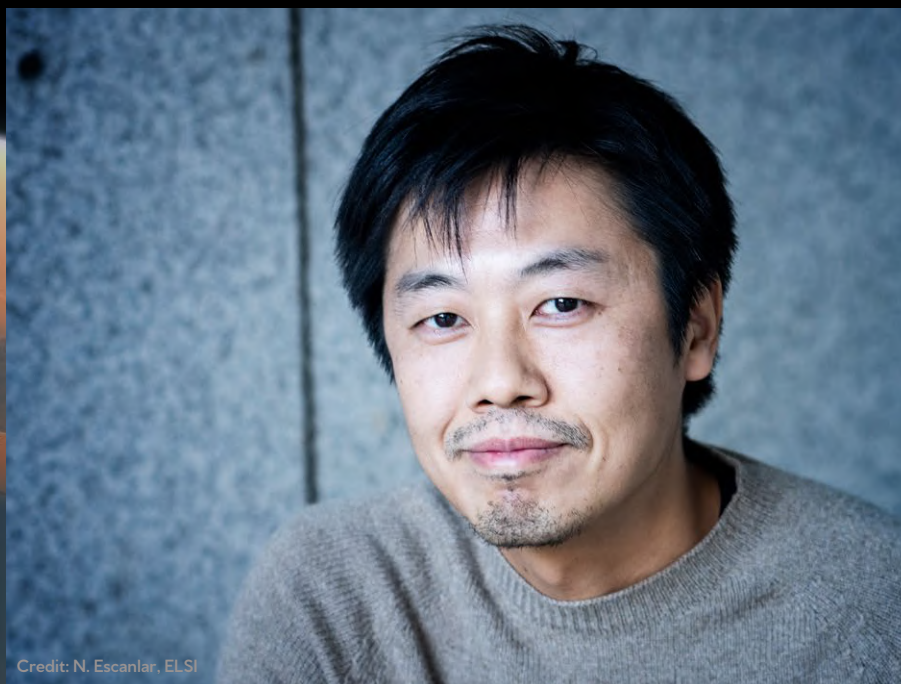


Rendering of Cassini moving over Titan, Enceladus and Saturn.

Aerospace Exploration Agency (JAXA), NASA and the European Space Agency (ESA). We will also focus on collaborations with these agencies in the next phase. I hope that the extra-terrestrial life predicted by ELSI might be found on Mars or other places.

planets other than Earth containing life. To achieve this, we must transcend Earth and consider the possibility of life elsewhere in the Universe.

Extra-terrestrial life would have been adapted to the environment of the planet or satellite that it lives in. What kind of life could possibly emerge, adapt and evolve in



Credit: N. Escanlar, ELSI

### About ELSI's new director

Yasuhito Sekine is a geochemist, a professor and the new director at the Earth-Life Sciences Institutes (ELSI), Japan. His research aims to address questions such as “what makes Earth a habitable planet?” and “is there life beyond Earth in the solar system?” by understanding environmental factors and the chemistry among them that give rise to, and support life in planets and satellites. His team studies on Earth, Mars, Saturn’s moons Enceladus and Titan, and Jupiter’s moon Europa among others.

Credit: Creative Commons

such an environment? We will introduce a new academic field called “synthetic biology”, which studies life based on the components it is made of and will explore the possible forms of extra-terrestrial life. This is a novel experimental attempt that has not been done anywhere in the world.

Specifically, we will design and create different forms of life from functional molecules. This approach is necessary to understand the origins of life on Earth and also the different forms of life that we have not yet seen.

### Q: As a researcher yourself, what kind of research do you do?

**A:** I am interested in researching the origins and evolution of the atmosphere and oceans in celestial bodies in the solar system, including Earth. In particular, I would like to understand how the chemical composition of the atmosphere and oceans in celestial bodies has evolved and what factors drove such changes. My research methods include laboratory experiments, analysis of exploration data, numerical models and field surveys.

### Q: Why did you decide to do research at ELSI?

**A:** I came to ELSI in June 2018. I decided to do my research at ELSI to conduct joint research with others in life science and complex systems science. After 10 years of focusing on chemistry, I felt it was time to shift my focus to life science in order to pursue research on extra-terrestrial life.

### Q: What kind of research institute does ELSI want to become in the next 10 years?

**A:** The fields of “origins of life” and “extra-terrestrial life” advocated by ELSI are of great interest to the general public. ELSI will not be a research institute only supported by some wealthy citizens, or a place for the State to invest large sums of money according to national policies. ELSI aims to continue its research through public support and to fulfil the universal curiosities and dreams we all share as human beings. There are not many places in the world where you can realize this, but I think Japan is one of them.



Field survey at the Mongolian frozen lakes.

Credit: ELSI

# SIZE MATTERS: SURGICAL IMAGING RECEIVES NANOPARTICLE ENHANCEMENT

**A nanoparticle's size is fine-tuned to offer high-resolution images before and during surgical procedures.**

Scientists have found a way to control the size of special nanoparticles to optimize their use for both magnetic resonance and near-infrared imaging. Their approach could help surgeons use the same nanoparticles to visualize tumours just before and then during surgery using the two different imaging techniques. Their findings were published in the journal *Science and Technology of Advanced Materials*.

"Magnetic resonance imaging is routinely used in pre-operative diagnosis, while surgeons have started using near-infrared fluorescence imaging during surgical procedures," says nanobiotechnologist Kyohei Okubo of Tokyo University of Science. "Our nanoparticle

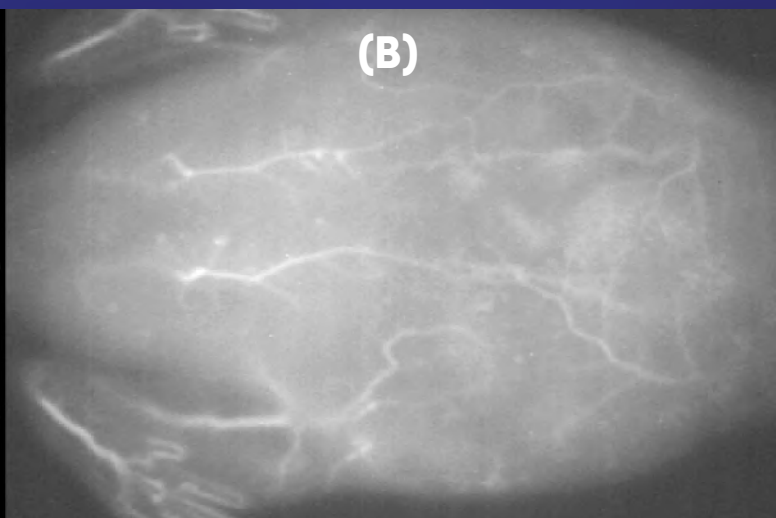
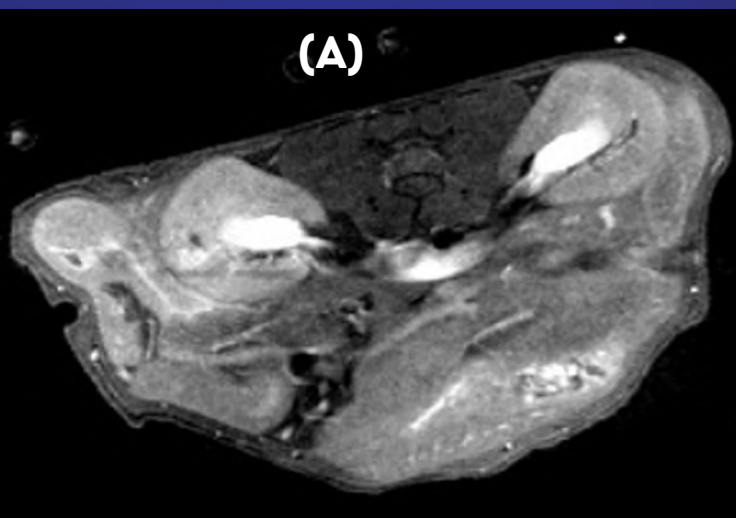
probes could provide a bimodality that will be clinically appealing to medical device researchers and doctors."

Ceramic nanoparticles made with the rare earth metals ytterbium (Yb) and erbium (Er) have demonstrated low toxicity and prolonged near-infrared luminescence, showing promise as a contrast agent in MRI scans and a fluorescing agent for near-infrared fluorescence imaging. Images of blood vessels and organs in live bodies can be obtained with the two imaging techniques by further modifying the nanoparticle surfaces with polyethylene glycol (PEG)-based polymers. But to improve image resolution, scientists need to have more control over nanoparticle size during the fabrication process.

Okubo and his colleagues used a step-by-step fabrication process that starts with mixing rare earth oxides in water and trifluoroacetic acid. The mixture is heated to form a solid. Then it is dissolved in solution, oleic acid is added and gas is removed. So-called rare-earth-doped ceramic nanoparticles form when this solution is cooled.

A few more steps lead to the coating of the nanoparticle surfaces with PEG. The scientists found they could slow the growth rate of the nanoparticles by increasing their concentration before the coating process. This allowed them to form nanoparticles 15 and 45 nanometres in diameter.

The team conducted a series of tests to examine the properties of their nanoparticles. They found that they could be used



The scientists injected the nanoparticle solution into the tail veins of live mice and were able to obtain high quality MRI (A) and near-infrared fluorescence (B) scans of tissues and blood vessels.

# Science and Technology of Advanced Materials

Open access journal STAM publishes outstanding research articles across all aspects of materials science, including functional and structural materials, theoretical analyses, and properties of materials.

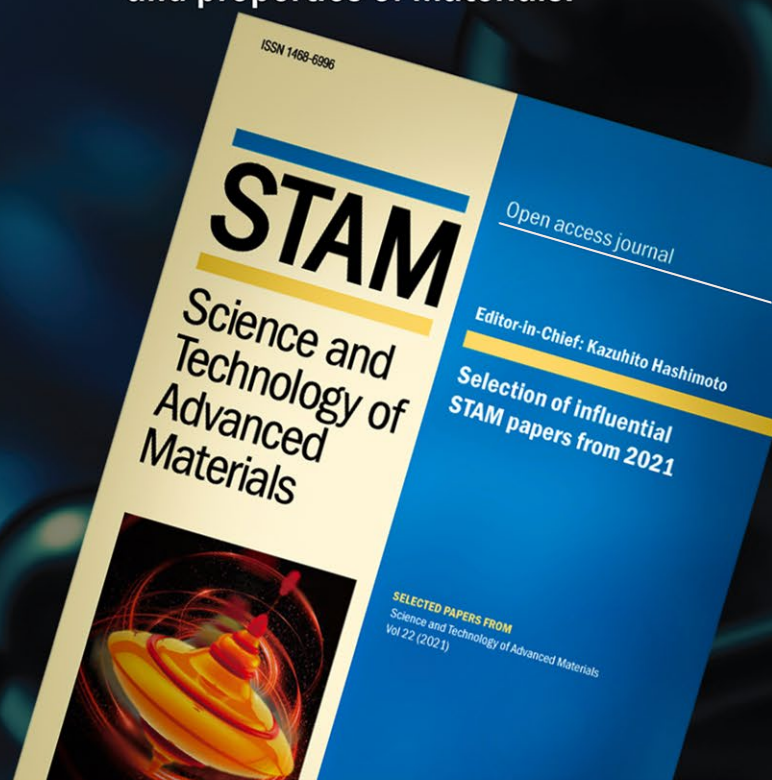
for obtaining high-quality images of blood vessels in live mice using MRI and near-infrared fluorescence imaging techniques. Further tests showed the nanoparticles exhibited minimal toxicity on mouse fibroblast cells when used in low concentrations. They also have a short half-life, meaning they would be cleared relatively quickly from the body, making them safe for clinical use.

The team next aims to investigate how different distributions of paramagnetic ions on the nanoparticles affect their magnetic properties. They will also study whether modifications could make the nanoparticles applicable for use in light-based photodynamic therapies for treating skin cancers and acne, for example.

Fibroblasts labeled with fluorescent dyes

## Did you know?

**Fibroblasts are the most common type of cell found in the scaffolding that gives structure and support to the body's tissues and organs. They produce substances that fill the spaces between cells and fibres in connective tissue and play an important role in wound healing.**



**STAM** Science and Technology of Advanced Materials



**NIMS** National Institute for Materials Science



**Empa**

Materials Science and Technology



**Taylor & Francis Group**  
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# MIND THE GAP: BONE DEFECTS GET NEW FILLING

**A novel biomaterial promotes bone tissue regrowth, showing promise for surgical procedures.**

A combination of a synthetic material with natural bone fills bone defects and encourages tissue regeneration, with potential for use during surgical procedures. The research was carried out at the Tohoku University Graduate School of Dentistry in Japan, and the results were published in the journal *Science and Technology of Advanced Materials*.

“Surgeons often use a patient’s own bone when they operate to fill and repair defects, but it can be hard to get enough amount of bone,” says Tohoku University biomaterials researcher Osamu Suzuki. “Reliable synthetic bone substitutes could make a big difference and this material seems to be one of the most promising.”

The synthetic bone substitute material is called octacalcium phosphate (OCP). Previous studies have shown that OCP

can promote bone formation and replace it with new bone over time. In the new study, Suzuki and his colleagues investigated the ability of OCP mixed with autologous bone to repair bone defects.

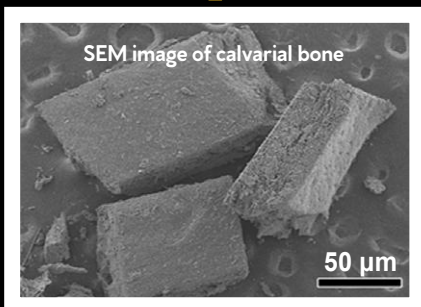
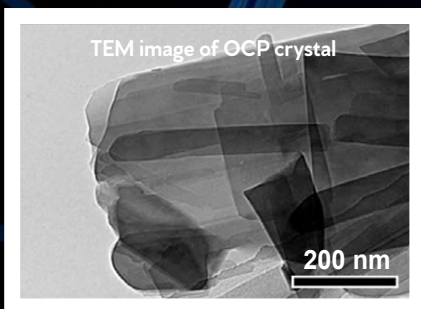
Working in rats, the researchers used OCP alone, bone from the animals, or a mixture of the two to fill a critical sized defect that cannot repair spontaneously in the skull. Bone formation of the natural material was higher than OCP alone. However, the researchers found that cells related to bone regeneration were accumulated by OCP mixed into natural (autologous) bone material for longer periods, suggesting it could replace some of the natural bone currently used in many clinical applications.

Histological analysis of new bone formation in the rats, and in a parallel set of cell culture experiments, showed that a

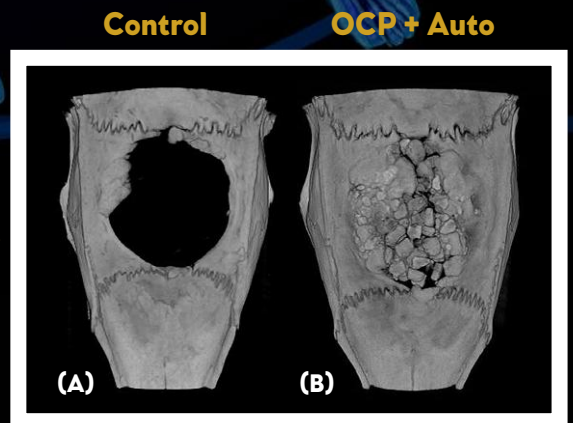
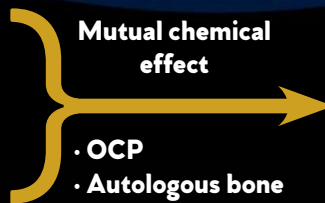
chemical interaction between the OCP and mineral crystals in the bone activated the regenerative properties of the mixture.

Suzuki says the findings suggest that OCP could be used to reduce the amount of autologous bone needed for bone repair.

A composite material developed by the author’s group that blends OCP with collagen has recently been approved as a bone filling material together with dental implant. Now, the researchers want to explore how the structure and property of the biomaterial influences its function and bone regeneration. They plan to develop further composite materials with natural or synthetic polymers and analyse the atomic structure of the resulting materials.



Mixing a synthetic substitute with natural bone material stimulated cellular activities and repair in experiments with rats.



# CANCER: GOING BACK TO THE BEGINNINGS

**A soft hydrogel could help scientists find treatments for drug-resistant cancer stem cells.**

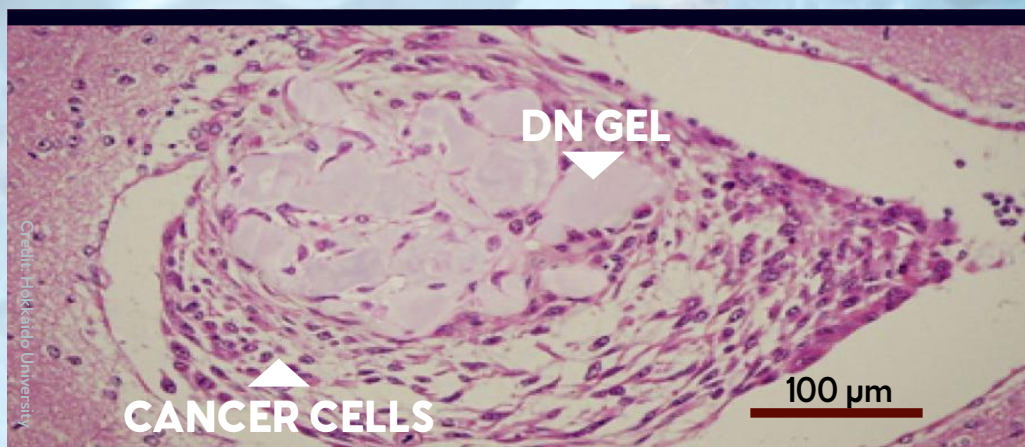
A new hydrogel developed by researchers at Hokkaido University and Japan's National Cancer Center Research Institute can rapidly reprogram cancer cells into cancer stem cells, according to a study published in the journal *Nature Biomedical Engineering*. The double network (DN) gel could help the process of developing targeted cancer therapies.

More than 8.6 million people die annually from cancer worldwide. Despite progress with treatments, the five-year survival rate of patients with advanced-stage cancer remains low. One reason is that cancer tissues contain stem cells that are resistant to chemo- and radiotherapies. These cells can hide within tumours or circulate in the body, causing cancer recurrence.

"Cancer stem cells are a major target for anti-cancer drugs, but they are difficult to identify because they are present in very small numbers in cancer tissues," explains Hokkaido University cancer pathologist Shinya Tanaka. "Understanding the molecular mechanisms of cancer stem cells is crucial for developing better cancer treatments."

Cancer stem cells require a very specific microenvironment. In this study, the research team investigated whether their DN gel could recreate the right conditions to reprogram cancer cells into stem cells. The DN gel consists of a network of two chemicals and incorporates a high volume of water, making it soft and wet like biological tissues.

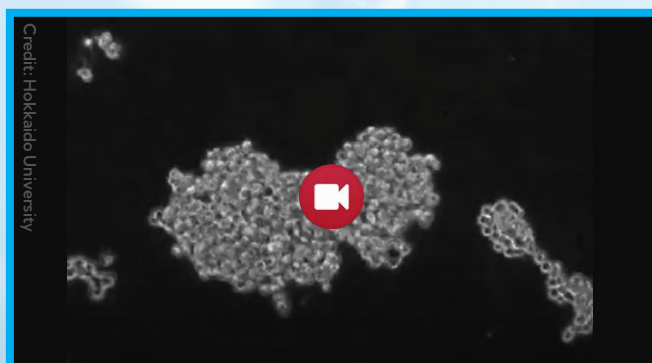
The DN gel successfully reprogrammed six different



The cancer stem cells cultured on the DN gel formed a tumor when injected into mice brain.

human cancer cell lines into stem cells in just 24 hours. When the cancer cells were placed on the DN gel, they started to form spherical structures and produce specific molecules known to be markers of cancer stem cells, suggesting they had been reprogrammed.

The researchers also uncovered some of the molecular mechanisms involved in cancer cell reprogramming. They found that calcium channel receptors and the protein osteopontin were essential for inducing tumour cells to revert into stem cells. They also found that human brain cancer cells cultured on the DN gel pro-



Human brain cancer cells forming spherical structures on the DN gel.

**Cancer stem cells require a very specific microenvironment. In this study, the team successfully reprogrammed six different human cancer cell lines into stem cells in just 24 hours.**

duced platelet-derived growth factor receptors. Adding a molecular inhibitor of these receptors allowed the scientists to target and eradicate the cancer stem cells.

Also, the brain cancer cells cultured on DN gel efficiently formed tumours when transplanted into mice brains.

The team says their DN gel could help pave the way for identifying new cancer stem cell markers and developing targeted therapies.

Credit: 123rf | crystallight

# MYANMAR: THE UNREMITTING PERSEVERANCE OF RESEARCHERS

Myanmar's military coup has created new challenges for the country's researchers.

On the morning of 1 February 2021, whilst the world was in the throes of a global pandemic, Myanmar's military deposed the elected members of government a day before they were due to be sworn in by parliament.

The coup has led to widespread civil unrest with devastating impacts on the country, especially the economic, health and education sectors. Still, researchers persevere.

The Knowledge for Democracy Myanmar (K4DM) program is a five-year initiative launched in 2017 by the International Development Research Centre (IDRC) and Global Affairs Canada to support local research and higher education capacity to generate evidence-based advice for public policy. Since the coup, the Myanmar researchers involved in the program have had to delicately balance continuing their projects while protecting themselves, their colleagues and the program's stakeholder involvement. Despite many challenges, they remain resolute, continue to break traditional barriers and support their country by providing evidence-based research.

Asia Research News spoke with some of these researchers to find out how their lives and projects have been impacted since the coup.

## Alex Aung Khant

### Tracking a digital uprising

Before fleeing Myanmar to Paris, France, Alex Aung Khant was the executive director of Urbanize, a Yangon-based policy institute, and an independent candidate in the 2019 Yangon City Development Committee Elections. He is a grand nephew of Aung San Suu Kyi, who served as Myanmar's state counsellor from 2015 until she was detained in 2021. Khant and a team of researchers are now tracking and documenting social media content to create a record of people's views and responses in the coup's aftermath. This 'digital diary' aims to be a crucial resource for understanding Myanmar's political trajectory and the successes and failures of a democracy movement in a time of crisis.

Researchers, especially in the field of politics, face extremely high risks due to the nature of their work. Indeed, many of my friends and colleagues have faced persecution, harassment and surveillance from the military, both individually and to their families.

In such a situation, the ability of researchers to do their work is severely hindered, as we have little physical security. Even for the few of us who can say we are safe, the mental capacity to conduct research under these circumstances is challenging, to say the least. Yet, we do the best we can, given what we have. That goes for all Myanmar's people. Despite the dire situation, we have no choice but to be resilient and not give up.

...many events occur daily in Myanmar that often tend to be left behind by the news cycle.

Our project mainly looks at social media discussions, as well as reported news, as a kind of historical collection of the events that have unfolded, combined with the public sentiments around those events. Overseen by SecDev Foundation, we call this project a Digital Diary, covering the first nine months since the coup.

We chose to do research on this because many events occur daily in Myanmar that often tend to be left behind by the news cycle.



**It is important to support fragmented scholar communities facing repression and turmoil. Continued support, especially of Myanmar's diaspora scholars who have strong ties with their country, will help defend the gains made in the past decade.**

Dr Edgard R. Rodriguez  
IDRC Myanmar Initiative Lead

The 200-year-old U Bein Bridge, located in Amarapura, could be the oldest in the world to be made out of teakwood.

Through our project, we want to track and categorize the important turning points and trajectory of the coup, the military's actions, and the public movement.

## Aye Lei Tun

### Research and resilience

Aye Lei Tun was gender program manager for Enlightened Myanmar Research Foundation, which conducted a three-year K4DM study on women's political participation in Myanmar. She is now in Canada, with help from the K4DM network and its connections, studying for a PhD in political science at McMaster University.

The coup strikes me as a nightmare. This is my first time to have witnessed such turmoil. In the first three months, most people in my country struggled with a variety of emotional states, ranging from hope to despair. But, starting in May, I believe the people's uprising to the military shifted to a more realistic approach, where we exited the fictitious universe in which we believed we could be saved by foreign intervention. We understood that we needed to seek out and form a strong alliance

among the diverse ethnic groups and to have a strategic approach to fight against the dictatorship.

As the military's suppression of civil society organizations became more severe, we had to halt our programmes, as the staff did not feel safe. Despite our insecurity, we continue supporting pro-democratic forces in whatever manner we can. We still have several limits in terms of our capacity to do research, including communication challenges, security concerns, and other unexpected roadblocks.



**If the original plan is no longer working, we consider an alternative approach..**

Currently, I'm assisting with a study on internally displaced persons (IDPs).

However, the situation is unpredictably volatile, and we cannot foretell what will happen tomorrow. Due to the increased number of serious armed conflicts around IDP areas, even some IDP camps continue to move. As a result, we must frequently alter our research strategy and plan in response to changing circumstances. Even when conducting phone interviews, we

are concerned about our safety.

We are still attempting to cope with these issues. If the original plan is no longer working, we consider an alternative approach as a backup.

A collaborative approach with local communities is the most effective method. We've improved our network and communication with local groups so that we can follow updates and potential solutions provided by local groups.

In the future, I want to see our society as politically matured, tolerating diversity, being critical and rational, which we have never had before. I believe that education may be the most important foundation for establishing a democratic society. Following my PhD, I would like to work in academia, particularly in research.

## Min Zaw Oo

### Monitoring violence

The executive director of the Myanmar Institute for Peace and Security (MIPS), Min Zaw Oo has a PhD degree in conflict analysis and resolution from Georgetown University in the US and has long been involved in Myanmar's peace process. He was exiled for 21



Photo from K4DM supported research: Voices of Ethnic People in Shan State about Gender Equality.

Credit: Shwe Paw Mya Tin

years before returning to Myanmar in 2012. MIPS was involved in a K4DM project in collaboration with the University of Toronto to study the impacts of centralization and decentralization on public service delivery.

The coup has been a major security threat for researchers. The post-coup security landscape makes research trips impossible. The regime's crackdown on the opposition movement has also driven many researchers out of the country. Those that have remained have been silenced by security threats from both sides of the conflict.



**The coup has elevated Myanmar's violence... not seen in the last 30 years.**

At MIPS, we are continuing to build our violence monitoring dataset, called the Township-based Conflict Monitoring System. The coup has elevated Myanmar's violence profile to an extent we have not seen in the last 30 years, so it is critical that we continue to monitor how different types of violence are changing.

We hope to continue our research efforts even under these circumstances. Due to the current security challenges, we have had to curtail our research activities in conflict zones, instead resorting to data collection from open sources. We have also increased our efforts to reach out to sources on the ground to triangulate our data collection.

### May Pannchi Studying for the homeland

Before the coup, May Pannchi was working with Myanmar Institute for Integrated Development to build research capacity for the staff of their local partner organizations. She was involved in the K4DM project titled "Voices of Ethnic People in Shan State about Gender Equality". She is now studying for a master's in environmental science at the University of Wisconsin-Madison in the United States.

The coup affected me personally and professionally. We were not able to do our research or development work. I tried to collect data related to the coup and also to support other people, but it was too

risky. I wasn't able to concentrate on my work and felt lost, depressed, unsafe and



**I overcame challenges because I had to. We have to be strong for our country's future.**

worried. I was a semester late joining the University of Wisconsin-Madison and I did not have enough time to prepare for my studies. Also, I had to leave my family and this was really hard for me.

I overcame those challenges because I had to. We have to be strong for our country's future.

I am studying environmental conservation. Before the coup, I travelled across Myanmar because of my work. Every time I went to the same place, I noticed environmental and climate changes that were getting worse. Our country is one of the least developed and most of our people are struggling for their daily survival, so they are unable to focus on the environment. Also, there are so many sectors we need to improve for conservation work, such as land use policies, environmental regulations for mega projects, and ensuring inclusiveness for



Soldiers undergoing training

people of different backgrounds in every sector. I felt I had to do something for our country's environment and to be more effective for my community. Also, I have a son and I want to bring positive impact and a better future for him and for future generations.

I really miss my home and I want to go back full of hope and security.

## ChamTha Kyaw

### Responding to change

ChamTha Kyaw is the executive director and co-founder of Pandita Development Institute, established in 2011 to provide a space for political and civic activists to contribute towards Myanmar's transition to democracy.

Before the coup, K4DM facilitated workshops and ongoing tailored training sessions to build our staff's research capacities. The program also provided a micro-grant for one of our strategic actions: sharing our social media communication experience among peer local civil society organisations. After the coup, K4DM's flexible micro-grant helped us conduct pi-

lot research to initiate our revised strategy.

Pandita is now researching civil society in post-coup Myanmar to advocate that international communities secure an enabling funding environment for a healthy civic space.



**Since the coup, research cannot be accomplished without taking risks.**

The research is helping us understand how civil society organisations (CSOs) have responded to dynamic political changes and drawbacks. Thanks to the active and detailed responses from a selection of local CSO leaders, our study uncovers the coping mechanisms, including direct impacts and challenges, and emerging trends in the civil society arena in post-coup Myanmar.

Since the coup, research cannot be accomplished without taking risks. The solidarity among the organisation's staff and the trust we have established with our research participants and other stakeholders have reasonably mitigated the risks and challenges.

## May Sabe Phyu

### Ensuring gender equality

May Sabe Phyu is the director of Gender Equality Network (GEN), which is participating in two K4DM projects to improve research capacity among partner organizations and raise awareness of gender issues among various sectors of society. The team has developed training manuals on gender issues and a booklet on gender standard terminology. They also established the Gender Resource Center, which holds reference materials and publications and has hosted a range of activities and discussions.

When COVID-19 hit Myanmar, we had to change our approach and conduct online events and campaigns. Even though we encountered several challenges due to the sudden shift, we found that audience engagement was more than we expected. Numerous discussions and meetings led to the collective development of recommendations for the Prevention of Violence against Women (PoVAW) bill that were sent to Union Parliament.



Women led protesters in the early days of the military coup.

We had to halt our advocacy activities when the military staged the coup on 1 February. The members of the junta raided offices of non-governmental and non-profit organizations and detained many staff members, social workers and activists. As a result, we have been trying to keep a low profile and prioritise the safety and security of our members and staff. Nevertheless, we continue to address discriminatory cultural norms, beliefs and prejudices while working on restoring democracy in our country.

Some of our members are raising emergency funds to relocate women to a safer place.

Less than 48 hours after the coup, GEN organized a meeting with other women's groups to form a Women's Human Rights Defenders network to collectively counter the country's urgent state of affairs. That network has transformed itself into a coalition and now stands as

one of the independent voices for the plight of women and girls in Myanmar.

GEN is actively collaborating with the women's groups and organizations to ensure women's needs are addressed. Within our membership, we have organizations providing helpline services for gender-based violence survivors. Some of our members are raising emergency funds to relocate and help women and girls to a safer place.

Myanmar is a patriarchal country with very low political participation of women. There have been many structural and cultural barriers for women to participate in politics that have not been systematically explored and documented. GEN hopes its research will improve understanding of the barriers women face to participate in politics so they can receive the support they need in the future.

I hope to see Myanmar on the path towards building a federal democratic union, the removal of the military from Myanmar politics once and for all, and the creation of a socially cohesive society where an individual has equal rights and opportunities by virtue of being a human.

## Pausa La Ring Serving the community

Pausa La Ring was a research team leader at Enlightened Myanmar Research Foundation. His work involved interviewing members of parliament and political party gatekeepers to study how candidates are selected for Myanmar elections. He also conducted research with local communities to understand attitudes towards and experiences of women in leadership positions.

The coup cost me a lot. I cannot travel across the country wherever I want to conduct my research now due to security concerns. Since we cannot travel and conduct face-to-face interviews in the communities, we have resorted to phone interviews. We are lucky that we have some contacts in the communities, so we snowball and ask them to introduce us to more respondents. This has been working so far but we still face challenges, such as lack of trust towards the researchers due to the current political situation or interviewees worrying their phone conversations are being monitored..



**Robust social science research is needed to further Myanmar's development goals. This is best done by those who will feel its impact. International support can help develop a local research culture that is based on local society's expectations and norms.**

Glutting, J. R., Z. X. Lee, and C. Galloway, 2022.

"Dusk in Hpa-An"

Photo taken in 2019 by visiting researcher Shona Loong



**Young women have played a crucial role in anti-coup protests in Myanmar, which is a great example to leave for younger generations.**

Our most recent research focus has been investigating the impacts of the COVID-19 pandemic and the dynamics of community level services after the coup.

I keep myself motivated by doing what I can. My personal security was in danger so I relocated. I am physically safe, but not mentally and emotionally. My team is in Yangon, but I communicate with them every day to keep them motivated, which also motivates me and gives me a sense of doing what I can for the community.

Generally, cultural norms and traditional beliefs make it difficult for our communities to accept and recognize the importance of gender equality. But young women have played a crucial role in anti-coup protests in Myanmar, which is a great example to leave for younger generations.

## Shona Loong Supporting Local Researchers

Researchers routinely work with partners outside their home countries. K4DM funded researchers are no exception, working with 30 international partners. Research partners must learn to accommodate the complex circumstances of colleagues living in areas of conflict. One of them is Shona Loong. During K4DM, Shona advised on research projects, facilitated by the SecDev Foundation, a Canadian think-tank working at the crossroads of security, development, and new technology.

In my K4DM-funded project with the SecDev Foundation, I am advising three groups of researchers working on Internet-related topics. All teams comprise at least one person from Myanmar, and they are regularly monitoring the ground situation and the safety of their researchers.

The question of what research safety and ethics look like post-coup is a difficult one. In my training as a researcher, I don't think I, or any of the people I have worked with, have faced the kinds of threats

people on the ground have. This is where trusting our local partners and admitting humility as a researcher is important.

I think some research is better than none, as long as the researchers are aware and reflexive of the limits of what they can do. I think there are many concerns about



**Research is critical... The important thing is to understand the limits of what we know and do not know.**

whether research can be as comprehensive and robust as we would like it to be. The answer is probably not. Not because researchers lack abilities, but because they face very real challenges in terms of the communications infrastructure and their own safety. In conflict areas, people cannot carry papers or laptops in case they are intercepted. That has real consequences. Still, research is critical at this juncture in Myanmar, when rumour circulates in international circles, and unknowing is sometimes used as a reason for inaction. The important thing is to understand the limits of what we know and do not know.



**Did you know?**

Maunakea is one of the best places for astronomical observations on Earth. For astronomers, minimal light pollution, high altitude, dry air, and a high percentage of clear nights produce the best results.

# GOING TO EXTREMES TO STUDY STARS FROM EARTH

Far from the white sandy beaches and palm trees of Honolulu, Hawaii, astronomers from around the world travel to the top of a volcano that looks like a plateau on Mars. Naoyuki Tamura, a project associate professor at the Kavli Institute for the Physics and Mathematics of the Universe, has been making that same journey to the top of Maunakea to supervise the construction of a new instrument for the Subaru Telescope.

**Q: You've been up to Maunakea many times. What is it like?**

**A:** I usually describe it as looking like Mars.

I was a graduate student the first time I went up. The air was so thin at 4,139 metres that I got altitude sickness. My head hurt and I lost my appetite. Eventually we made it down to the dormitories at 2,800m above sea level, but because the air was still thin, I had trouble getting to sleep. Even after we made it back down to base, it took a while before I got my appetite back.

But even in those conditions, you have work to do and you still need to use your head. So those first trips were very challenging.

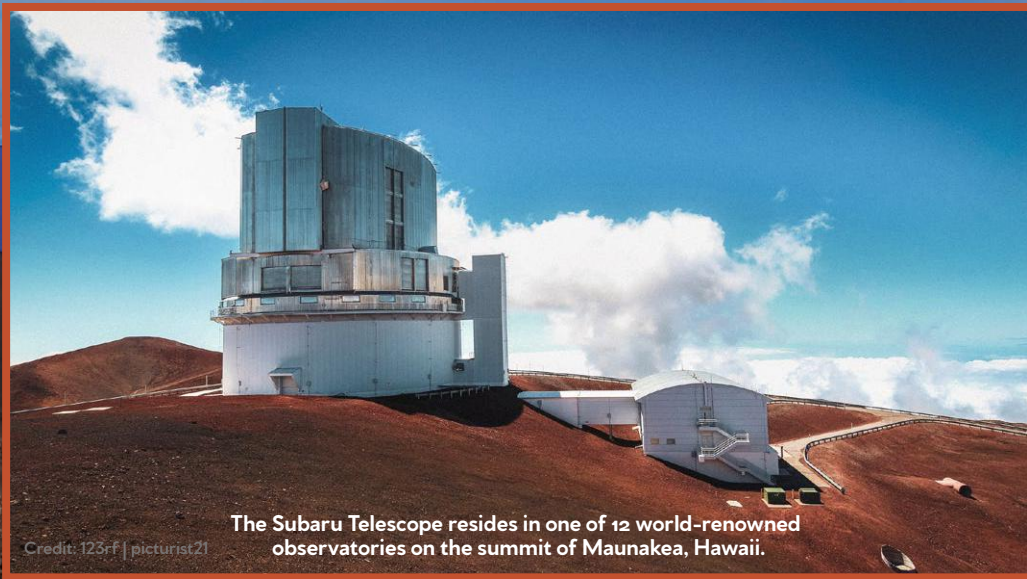
Since then, I make sure I have three things. First, I don't feel well when I'm cold so I make sure I am wearing warm clothes. I also feel worse if I stay hungry, so I always pack a few snacks. When I get headaches, it's not terrible but my eyes start to hurt and my vision can get blurry, so I always make sure I have a box of aspirin on me.

**Q: What does your typical work-day look like on Maunakea?**

**A:** I leave the base at Hilo by 8am and head by car to the dormitory on Maunakea at 2,800m above sea level. There's a half hour break there to acclimatize to the altitude. Once that is over, it is time to hop back into the car and drive up to the top of the mountain.

Our work hours vary depending on what needs to be done that day. In general, we arrive at the summit around 10am and leave by 4pm to give the team using the telescope at night time to get organized.

*According to Tamura, working at a telescope has never been a 9 to 5 office job. The telescope's onsite staff can work for days leading up to a scheduled use to ensure that as many researchers as possible can carry out their observations at night. But that means all the maintenance and troubleshooting work on the telescope needs to be done during the day. That cuts into Tamura's time. Even though he is working on a next-generation science project,*



The Subaru Telescope resides in one of 12 world-renowned observatories on the summit of Maunakea, Hawaii.

Credit: 125rf | picturist21



View from the Subaru Telescope of broader landscape with Caltech Submillimeter Observatory.

*the work of other astronomers is equally important, and so Tamura alters his work schedule to fit in with the schedules of other researchers.*

*Because of these reasons, researchers spend much of their time at the base in the town of Hilo, which Tamura has been visiting one to three times a year these past few years. He has been overseeing the construction of a large scientific instrument, like completing a jigsaw puzzle. Over the past few years, his collaboration has been constructing and testing several components at their individual institutes: a prime focus instrument, a metrology camera system, four*

*spectrographs and four fibre cables. Tamura says these individual components are like puzzle pieces, and putting them together on the Subaru Telescope will create something unique.*

**Q: What are you building up there?**

**A:** The Subaru Telescope captures images of stars and galaxies in the night sky. We're building a Prime Focus Spectrograph (PFS) that will split up the light from these celestial objects into their various wavelengths. This can reveal different details about an object, such as its motion. Once complete, the PFS will be able to process about 2,400 objects at once.

*While the PFS is one of a kind in this sense, it is unique in that it will be used on an 8.2m telescope, unlike most of the others on much smaller ones. What Tamura is excited about is that once finished, the PFS will be able to collect information, or spectra, from a couple thousand celestial objects at once, taking advantage of the large light-gathering power of the telescope as well as the other competent capabilities of the PFS itself.*

**Q: How far along are you?**

**A:** Different parts of the PFS have been arriving to Hawaii since 2018. I would say we're about 70% there. Bear in mind we

Credit: PFS Project

Read the article in [Asia Research News 2016](#) on early plans for PFS to uncover clues about the nature of dark matter, dark energy, galaxy formation and evolution.

Kavli IPMU's Naoyuki Tamura has been working with researchers from more than 20 institutions to build the Prime Focus Spectrograph (PFS) on site at the Subaru Telescope.

Credit: PFS Project



will spend about a year testing and calibrating the equipment on site because there's always something that doesn't work quite as planned.

**Q: So do you help put the instrument together?**

**A:** Of course I'll help with tightening the screws, but my role now is more to set priorities, decide what our goals are, and to make sure I keep an eye on how the entire project is progressing.

In my last project, I was working with researchers from three countries. Now the PFS has more than 20 collaborating organizations in seven countries, so it is a new experience for me.

This is a difficult task at this altitude. Altitude sickness affects the brain, and so

it is easy to lose one's judgement. Communication can easily break down. In this project, the researchers and engineers spend most of their time working in separate teams, developing individual pieces. I am the bridge that keeps them connected. On the mountain, teams must work together to get things done efficiently in the limited time frame, so coordination and bridging are quite important.

**Q: How has COVID-19 affected work?**

**A:** The pandemic has made things difficult. Early in the pandemic, the rules changed to allow only two people to ride together in a car, making it time-consuming to get everyone on site.

Teams usually transport equipment from their home countries to Hawaii by plane,

and then they are loaded onto a truck and taken to Hilo first for a check-up or directly to the summit of Maunakea. During the early stages of the pandemic there were fewer cargo flights and higher transportation costs. At one point, a flight that was supposed to carry a piece of equipment from Honolulu to Hilo was rescheduled, but the equipment's tall crate couldn't fit into the hull of the rescheduled plane, so the researchers had to transport the piece to Hilo by ship.

**Q: You have been up there so many times, has the scene changed to you?**

**A:** I've been up many times, so it has become a familiar sight. But the sky is so close. This is true no matter whether it is day or night.

Credit: PFS Project





Behind every **breakthrough**  
there is a **story.**

**It's time for Asia Research News to tell yours.**

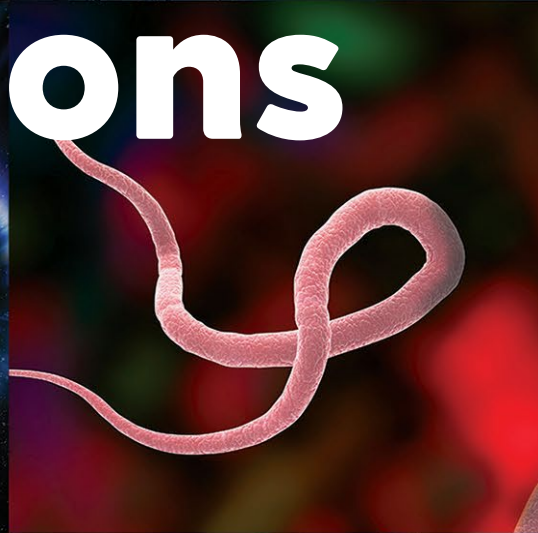
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