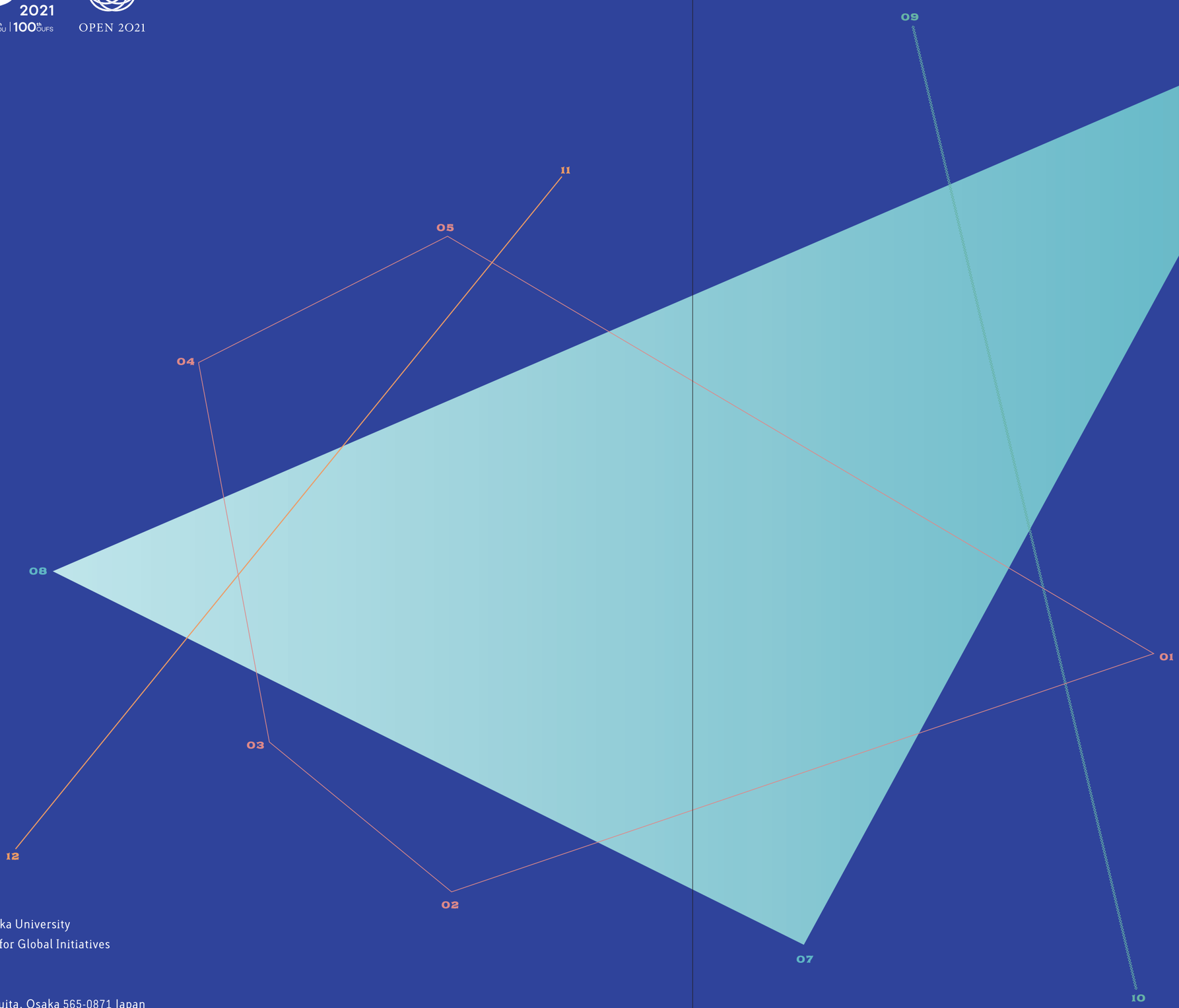
大阪大学
OSAKA UNIVERSITY

Connect
Coalesce
Compassion
2021
90th OU | 100th OUFS

OPEN 2021



Osaka University Research Profile 2018

A Collection of Twelve Impactful Articles from Osaka University

Published by: Osaka University
Edited by: Center for Global Initiatives

Osaka University
1-1 Yamadaoka, Suita, Osaka 565-0871 Japan

www.osaka-u.ac.jp

Osaka University was founded in 1931 as one of the seven national universities of Japan and now has expanded to one of Japan's leading comprehensive universities. The University has embarked on an open research revolution with its vision of openness for 2021 from its position as Japan's most innovative university and one of the most innovative institutions in the world according to the Nature Index 2017 Innovation. The university's ability to innovate from the stage of fundamental research through the creation of useful technology with economic impact stems from its broad disciplinary spectrum.

Facts and Figures

Faculty and Staff *female staff

(as of May 1, 2018)

3,541	3,113
*654	*2,107
Academic Staff	Researchers, Administrative Staff, Medical Staff, etc.

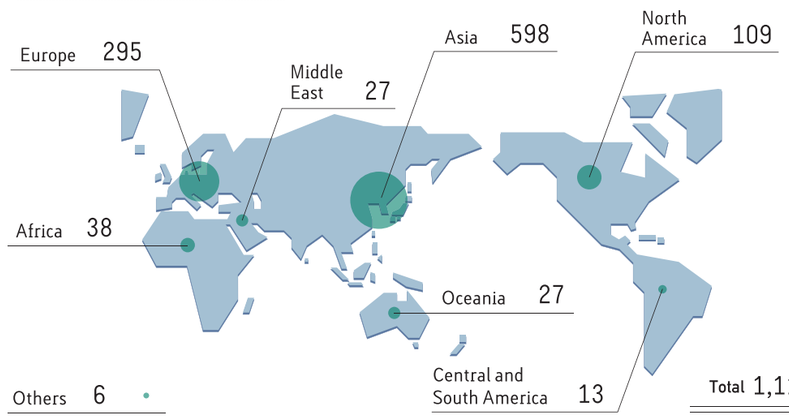
Students

(as of May 1, 2018)

15,250	8,054
Undergraduate Students	Graduate Students

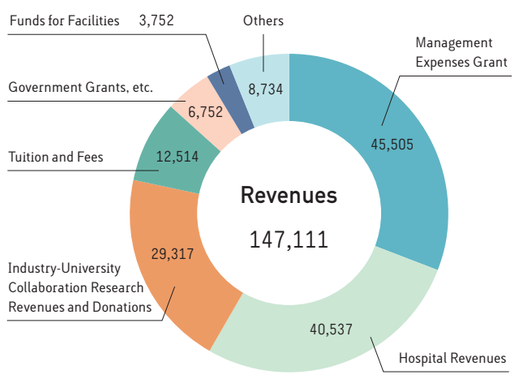
International Researchers

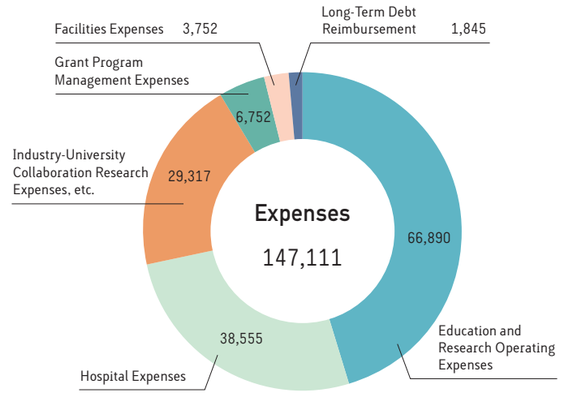
(Inbound) April 1, 2017- March 31, 2018



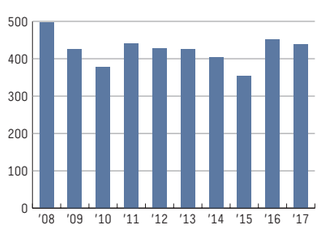
Budgets

FY 2018, in millions of yen



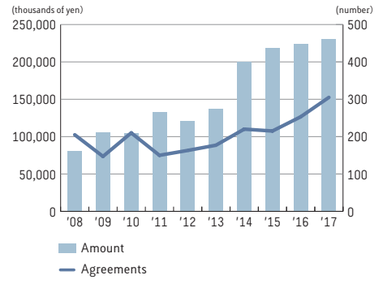


The Number of Invention Disclosures

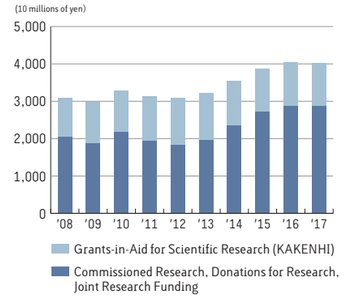


License Agreements and Income

(including licensing, assignment and MTA)



External Funding



01

Life Sciences & Medicine

Shohei Koyama

Department of Respiratory Medicine and Clinical Immunology, Graduate School of Medicine

Certain brain cancers are associated with low numbers of immune system T-cells circulating in the peripheral blood. Low T-cell numbers can be a side-effect of cancer treatment. But it now appears that there is more to the story of these missing T-cells.

Researchers from multiple institutions, including Osaka University, have now revealed how brain cancers escape detection by the immune system by inhibiting the proper functioning of T-cells. The researchers revealed the high concentrations of T-cells trapped in bone marrow and propose the strategy by which cancers sequester these cells. They recently published their findings in *Nature Medicine*.

The researchers reviewed imaging results and blood tests of patients with brain cancer and confirmed that these patients had low T-cell levels, compared to controls, even prior to being treated. The patients also had contracted spleens, indicating the T-cells were not hiding there. The same results were seen in mice. Remarkably, analysis of mouse bone marrow revealed a large expansion in T-cell numbers.

"When we examined the bone marrow of human patients, we found the same sequestration of T-cells as in the mice," study lead author Pakawat Chongsathidkiet says. "When there was tumor in the brain, the immune cells that would normally attack the tumor appeared to be trapped in the bone marrow."

"Brain cancer potentially resists immunotherapies by trapping T cells in bone marrow"

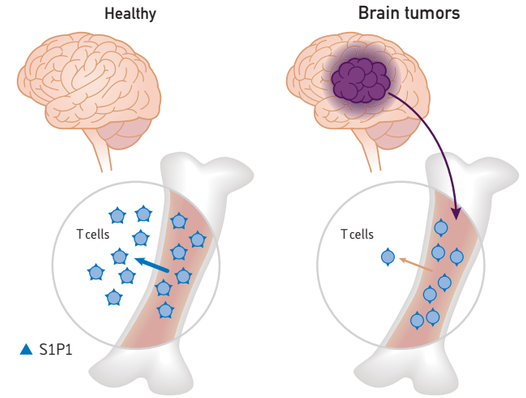
An international research team finds immune cells needed to fight cancer are trapped in the bone marrow by some brain tumors

Using flow cytometry, the researchers found a strong inverse relationship between the level of the T-cell surface protein S1P1 and T-cell numbers in the bone marrow. Functioning S1P1 is needed for T-cells to leave the bone marrow and other immune system organs, such as spleen, lymph nodes and thymus. The effects of the tumor appeared to prevent cells from leaving the bone marrow.

Next the researchers uncovered the mechanism by which the T-cells can be freed. Blocking the cell's ability to internalize S1P1 caused the T-cells to re-emerge from the marrow.

"We expect these results to provide clues that will help improve the effects of immunotherapy treatments for brain tumors," says coauthor Shohei Koyama. "It should be possible to induce these trapped T lymphocytes to migrate and attack the tumor."

Overall, these findings suggest that therapies that activate T-lymphocytes may be useful adjuncts to current treatment of cancers inside the skull.



The level of the T-cell surface protein S1P1 decreased in brain tumor patients, leading to a relative increase in T-cell numbers in the bone marrow.

[reference]

Chongsathidkiet P. *et al.* (2018) Sequestration of T cells in bone marrow in the setting of glioblastoma and other intracranial tumors. *Nature Medicine* 24. 1459–1468. DOI : 10.1038/s41591-018-0135-2

https://resou.osaka-u.ac.jp/en/research/2018/20180814_1

02

Life Sciences & Medicine

Kohji Nishida

Department of Neural and Sensory Organ Surgery, Graduate School of Medicine

The discovery of pluripotent stem cells, which have the ability to differentiate into the huge range of different cell lineages that make up the human body, signaled the start of a new era in biological science and medicine. Although we are also now able to reprogram regular cells to exhibit this pluripotency, we still have much to learn about the different cues that lead such cells towards a particular cell fate, including the cells that make up the eye.

A new study reported in the journal *Cell Reports* has shed light on this by showing that, by growing human pluripotent stem cells on different forms of a protein called laminin, they can be induced to become corneal cells, retinal cells, and others. The cells could then be collected and used for a range of therapeutic purposes.

This study builds on earlier work by this Osaka University-centered group, which showed that exposing these stem cells to an isoform of laminin, a structural component of the matrix that fills the space outside of cells, led to the creation of cell colonies arranged as four concentric zones (2016 *Nature*). Each of these zones exhibited characteristics specific to a particular anatomical component of the eye.

Here, the team grew these stem cells under conditions exclusively containing other laminin isoforms that are present in the eye, finding that this led to the creation of cells with different mobilities, densities, and tendencies to interact. They then showed that, for each particular laminin isoform, the different cells produced in the cultures matched those in different parts of the eyes of embryonic mice where the same laminin isoform predominated.

"We found that the different laminin isoforms affected whether and how fast the cells migrated outwards from the point at which the colony was originally seeded and the density at which the cells in the colony were packed," says corresponding author Ryuhei Hayashi. "These different behaviors were related to the kinds of cells that the stem cells turned into, showing that we could specifically produce an ocular cell type just by choosing the appropriate type of laminin for the targeted cells."

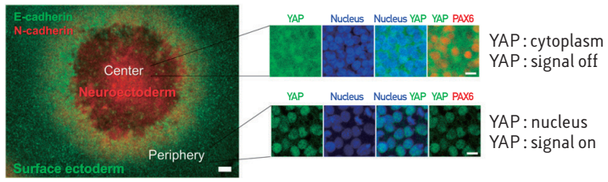
"Eye-opening study differentiates iPS cells into various ocular lineages"

Osaka University-led team reveals how stem cells can be induced to differentiate into the various cells that make up the eye, with potential implications for treating ocular diseases

The researchers then investigated the molecular mechanisms behind these different behaviors. They found that the form of laminin that gave rise to colonies with four concentric rings caused the contraction of extracellular structural scaffolds that tether cells together, producing higher-density colony centers. This in turn led to the inactivation of a protein called YAP, which promoted the differentiation into retinal-like cells in the colony centers.

"Now that we can use different laminins to program stem cells to become particular cells found in different parts of the eye, we can harvest and apply them in treatments for a range of ocular diseases," last author Kohji Nishida says. "This could be an extremely useful tool in the field of ophthalmology."

The authors are planning to conduct a clinical study to treat patients with damaged corneas using iPS-cell derived corneal epithelial sheets in 2019.



LN511E8 led to YAP inactivation and retinal differentiation in hiPS cell colony centers. (© 2018 Shibata *et al., Cell Reports*)

[reference]

Hayashi R. *et al.* (2016) Co-ordinated ocular development from human iPS cells and recovery of corneal function. *Nature* 531. 376–380. DOI: 10.1038/nature17000

https://resou.osaka-u.ac.jp/en/research/2016/20160310_2

Shibata S. *et al.* (2018) Selective laminin-directed differentiation of human induced pluripotent stem cells into distinct ocular lineages. *Cell Reports* 25. 1668–1679. DOI: 10.1016/j.celrep.2018.10.032

https://resou.osaka-u.ac.jp/en/research/2018/20181205_2

Tomoji Kawai

Department of Bio-Nanotechnology,
The Institute of Scientific and Industrial Research

Influenza is a highly contagious respiratory disease of global importance, which causes millions of infections annually with the ever-present risk of a serious outbreak. Passive vaccination is the only method available for partial control of the virus. Rapid diagnosis of influenza has been explored to prevent outbreaks by enabling medication at very early stages of infection; however, diagnostic sensitivity has not been high enough, until now.

In a new study published in *Scientific Reports*, a team of researchers led by Tomoji Kawai at Osaka University explored the usefulness of combining a single-particle nanopore sensor with artificial intelligence technology, and found that this approach created a new virus typing method that can be used to identify single influenza virions.

Genetic methods can identify many virus species, but require time-intensive processes and specialized staff. Therefore, these methods are unsuitable for point-of-care screening. In a novel approach, the researchers designed a sensor that could assess distinct nanoscale properties of influenza virions within physiological samples.

"We used machine-learning analysis of the electrical signatures of the virions," says corresponding author Makusu Tsutsui. "Using this artificial intelligence approach to signal analysis, our method can recognize a slight current waveform difference, which cannot be discerned by human eyes. This enables high-precision identification of viruses."

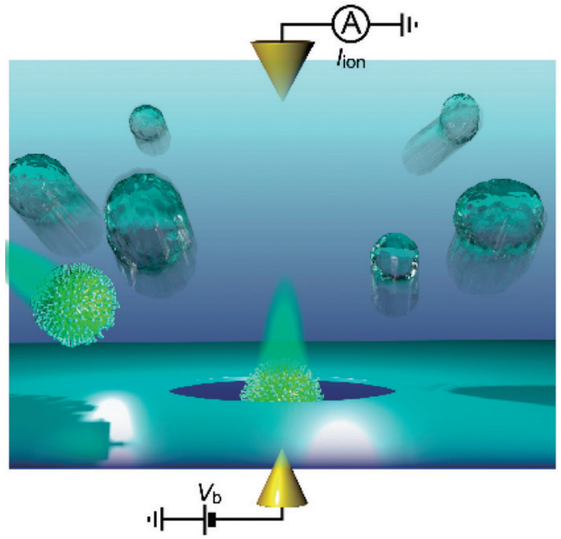
In testing this sensor, the research team found that electroosmotic flow (liquid motion induced by an electric current across the nanopore) through the pore channel could block the passage of non-virus particles. This ensured that the only particles evaluated by the sensor were virus particles, regardless of the complexity of the sample that contained those viruses.

"Our testing revealed that this new sensor may be suitable for use in a viral test kit that is both quick and simple," says lead author Akihide Arima, "Importantly, use of this sensor does not require specialized human expertise, so it can readily be applied as a point-of-care screening approach by a wide variety of healthcare personnel."

In addition to enabling early detection of influenza, this nanosensor method could be modified to enable early detection of other viral particles. This would enable rapid prevention and tracking for a variety of local epidemics and potential pandemics.

"How low can we go? Nanopore detection of single flu viruses to control outbreaks"

Study shows that label-free digital diagnostics based on nanopore analytics and AI technology can characterize individual virions by their distinct physical features



Detection of a single influenza virion using a solid-state nanopore.

[reference]

Arima A. *et al.* (2018) Selective detections of single-viruses using solid-state nanopores. *Scientific Reports* 8:16305. DOI:10.1038/s41598-018-34665-4

https://resou.osaka-u.ac.jp/en/research/2018/20181121_1

Kiyoshi Takeda [1,2]

1 *Department of Microbiology and Immunology, Graduate School of Medicine*
2 *WPI Immunology Frontier Research Center*

For at least a decade, researchers have known that normal bacteria in the gut can induce intestinal immune cells to extend tentacle-like structures, known as dendrites, to "capture" antigens, triggering both immediate and long-term immune responses. What was less clear was how the bacteria activate this process. Now, a research team led by Osaka University has found that the molecules responsible have been hiding in plain sight.

Metabolites are small molecules produced during metabolism, the chemical processes that occur inside all living cells to keep them ticking over. Metabolic pathways have been intensively studied in many organisms, with most common metabolites having very few secrets. Yet, in a recent paper published in the journal *Nature*, the team describes how they made an important discovery—two well-known metabolites, pyruvate and lactate, are in fact the instigators of dendrite protrusion by CX_3CR1^+ macrophages in the small intestine.

"After studying the available research, we hypothesized that bacterial metabolites present in the small intestine could possibly mediate dendrite protrusion," explains lead author Naoki Morita. "After purifying different fractions from the contents of the small intestines of mice, we discovered that lactic acid and pyruvic acid, produced by lactic acid bacteria in the normal gut flora, act directly on intestinal macrophages."

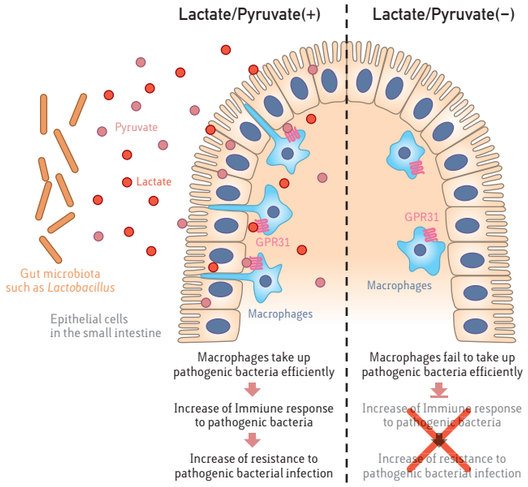
Next, the researchers identified GPR31, a protein residing on the surface of small intestinal macrophages, as the specific receptor for the two metabolites. Mice lacking GPR31 showed reduced dendrite protrusion by CX_3CR1^+ cells after being administered pyruvate or lactate and, as a result, decreased antibody production following infection with a non-pathogenic strain of *Salmonella*. However, the most significant revelation was yet to come.

"We then examined whether pre-treatment of normal mice with pyruvate or lactate as well as non-pathogenic *Salmonella* could protect against infection with a virulent strain of the bacterium," says co-lead author Eiji Umemoto. "As we predicted, normal pre-treated mice, but not pre-treated GPR31-defective mice, showed increased survival and an enhanced immune response following infection with the virulent *Salmonella* strain."

Corresponding author Kiyoshi Takeda explains that the research has multiple clinical applications. "Because these metabolites enhance the immune response, they could be used to improve the effectiveness of oral vaccines, while GPR31 is a promising target for therapies aimed at eliminating intestinal pathogens. Because of this, we expect that lactic acid, pyruvic acid, and GPR31 will all be explored in the near future as new targets for activating immunity."

"Small metabolites have big effects on the intestinal immune response"

Researchers find that common bacterial metabolites pyruvate and lactate enhance the intestinal immune response and guard against infection by important gut pathogens



Role of bacterial metabolites lactate and pyruvate in intestinal immune response.

[reference]

Morita N. *et al.* (2019) GPR31-dependent dendrite protrusion of intestinal CX_3CR1^+ cells by bacterial metabolites. *Nature*. DOI:10.1038/s41586-019-0884-1

https://resou.osaka-u.ac.jp/en/research/2019/20190124_1

Hideshi Ishii

Department of Gastroenterological Surgery,
Graduate School of Medicine

In cancer patients, there can be tremendous variation in the types of cancer cells from one patient to another, even within the same disease. Identification of the particular cell types present can be very useful when choosing the treatment that would be most effective, but the methods of doing this are time-consuming and often hampered by human error and the limits of human sight.

In a major advance that could signal a new era in cancer diagnosis and treatment, a team at Osaka University and colleagues have shown how these problems can be overcome through an artificial intelligence-based system that can identify different types of cancer cells simply by scanning microscopic images, achieving higher accuracy than human judgment. This approach could have major benefits in the field of oncology.

The system is based on a convolutional neural network, a form of artificial intelligence modeled on the human visual system. In this study, reported in the journal *Cancer Research*, this system was applied to distinguish cancer cells from mice and humans, as well as equivalent cells that had also been selected for resistance to radiation.

"We first trained our system on 8,000 images of cells obtained from a phase-contrast microscope," corresponding author Hideshi Ishii says. "We then tested its accuracy on another 2,000 images, to see whether it had learned the features that distinguish mouse cancer cells from human ones, and radio-resistant cancer cells from radiosensitive ones."

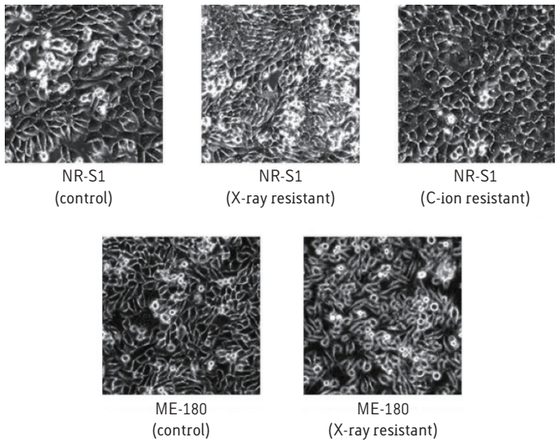
"Cancer cells distinguished by artificial intelligence–based system"

Researchers have developed a system using artificial intelligence that can automatically differentiate between different types of cancer cell, potentially paving the way for the rapid, automated determination of appropriate individualized cancer treatments

Upon creating a two-dimensional plot of the findings obtained by the system, the results for each cell type clustered together, while being clearly separated from the other cells. This showed that, after training, the system could correctly identify cells based on the microscopic images of them alone.

"The automation and high accuracy with which this system can identify cells should be very useful for determining exactly which cells are present in a tumor or circulating in the body of cancer patients," lead author Masayasu Toratani says. "For example, knowing whether or not radioresistant cells are present is vital when deciding whether radiotherapy would be effective, and the same approach can then be applied after treatment to see whether it has had the desired effect."

In the future, the team hopes to train the system on more cancer cell types, with the eventual goal of establishing a universal system that can automatically identify and distinguish all such cells.



Representative microscopic images of cancer cells and radioresistant cells

[reference]

Toratani M. *et al.* (2018) A convolution neural network uses microscopic images to differentiate between mouse and human cell lines and their radioresistant clones. *Cancer Research* 78:23. 6703-6707. DOI:10.1158/0008-5472.CAN-18-0653

https://resou.osaka-u.ac.jp/en/research/2018/20181206_1

Megumi Akai-Kasaya

Department of Precision Science and Technology,
Graduate School of Engineering

The brain requires surprisingly little energy to adapt to the environment to learn, make ambiguous recognitions, have high recognition ability and intelligence, and perform complex information processing.

The two key features of neural circuits are "learning ability of synapses" and "nerve impulses or spikes." As brain science progresses, brain structure has been gradually clarified, but it is too complicated to completely emulate. Scientists have tried to replicate brain function by using simplified neuromorphic circuits and devices that emulate a part of the brain's mechanisms.

In developing neuromorphic chips to artificially replicate the circuits that mimic brain structure and function, the functions of generation and transmission of spontaneous spikes that mimic nerve impulses (spikes) have not yet been fully utilized.

A joint group of researchers from Kyushu Institute of Technology and Osaka University studied current rectification control in junctions of various molecules and particles adsorbed on single-walled carbon nanotube (SWNT), using conductive atomic force microscopy (C-AFM), and discovered that a negative differential resistance was produced in polyoxometalate (POM) molecules adsorbed on SWNT. This suggests that an unstable dynamic non-equilibrium state occurs in molecular junctions.

In addition, the researchers created extremely dense, random SWNT/POM network molecular neuromorphic devices, generating spontaneous spikes similar to nerve impulses of neurons

POM consists of metal atoms and oxygen atoms to form a 3-dimensional framework. Unlike ordinary organic molecules, POM can store charges in a single molecule. In this study, it was thought that negative

"Brain function partly replicated by nanomaterials"

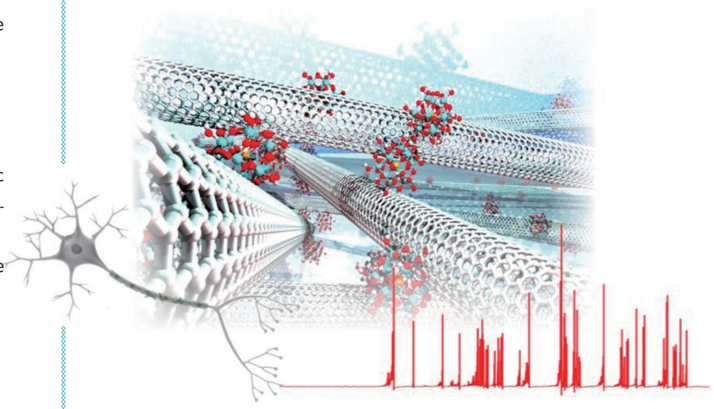
Molecular/carbon nanotube network devices enable artificial spiking neurons that mimic nerve impulse generation

differential resistance and spike generation from the network were caused by nonequilibrium charge dynamics in molecular junctions in the network.

Thus, the joint research group led by Megumi Akai-Kasaya conducted simulation calculations of the random molecular network model complexed with POM molecules, which are able to store electric charges, replicating spikes generated from the random molecular network. They also demonstrated that this molecular model would very likely become a component of reservoir computing devices. Reservoir computing is anticipated as next-generation artificial intelligence (AI). Their research results were published in *Nature Communications*.

"The significance of our study is that a portion of brain function was replicated by nano-molecular materials. We demonstrated the possibility that the random molecular network itself can become neuromorphic AI," says lead author Hirofumi Tanaka.

It is expected that this group's achievements will greatly contribute to the development of neuromorphic devices of the future.



Spontaneous spikes similar to nerve impulses of neurons were generated from a POM/CNT complexed network.

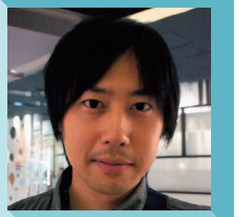
[reference]

Tanaka H. *et al.* (2018) A molecular neuromorphic network device consisting of single-walled carbon nanotubes complexed with polyoxometalate. *Nature Communications* 9:2693. DOI:10.1038/s41467-018-04886-2

https://resou.osaka-u.ac.jp/en/research/2018/20180713_1

07

Engineering



Hisashi Ishihara

Department of Adaptive Machine Systems,
Graduate School of Engineering

Japan's affection for robots is no secret. But is the feeling mutual in the country's amazing androids? We may now be a step closer to giving androids greater facial expressions to communicate with.

While robots have featured in advances in healthcare, industrial, and other settings in Japan, capturing humanistic expression in a robotic face remains an elusive challenge. Although their system properties have been generally addressed, androids' facial expressions have not been examined in detail. This is owing to factors such as the huge range and asymmetry of natural human facial movements, the restrictions of materials used in android skin, and of course the intricate engineering and mathematics driving robots' movements.

A trio of researchers at Osaka University has now found a method for identifying and quantitatively evaluating facial movements on their android robot child head. Named Affetto, the android's first-generation model was reported in a 2011 publication. The researchers have now found a system to make the second-generation Affetto more expressive. Their findings offer a path for androids to express greater ranges of emotion, and ultimately have deeper interaction with humans.

The researchers reported their findings in the journal *Frontiers in Robotics and AI*.

"Surface deformations are a key issue in controlling android faces," study co-author Minoru Asada explains. "Movements of their soft facial skin create instability, and this is a big hardware problem we grapple with. We sought a better way to measure and control it."

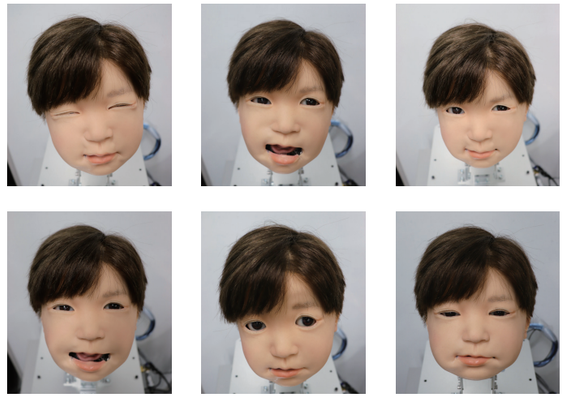
"Researchers in Japan make android child's face strikingly more expressive"

Researchers employ a quantitative approach to add rich nuance to the expressions of their robot child face

The researchers investigated 116 different facial points on Affetto to measure its three-dimensional movement. Facial points were underpinned by so-called deformation units. Each unit comprises a set of mechanisms that create a distinctive facial contortion, such as lowering or raising of part of a lip or eyelid. Measurements from these were then subjected to a mathematical model to quantify their surface motion patterns.

While the researchers encountered challenges in balancing the applied force and in adjusting the synthetic skin, they were able to employ their system to adjust the deformation units for precise control of Affetto's facial surface motions.

"Android robot faces have persisted in being a black box problem: they have been implemented but have only been judged in vague and general terms," study first author Hisashi Ishihara says. "Our precise findings will let us effectively control android facial movements to introduce more nuanced expressions, such as smiling and frowning."



The newly developed face of the Affetto child android robot. Affetto's face was first revealed in published research in 2011.

[reference]

Ishihara H., Wu B. and Asada M. (2018) Identification and evaluation of the face system of a child android robot Affetto for surface motion design. *Frontiers in Robotics and AI* 5:119. DOI:10.3389/frobt.2018.00119

https://resou.osaka-u.ac.jp/en/research/2018/20181114_1

08

Engineering

Takahiro Hara

Department of Multimedia Engineering
Graduate School of Information Science and Technology

The aim of many e-commerce sites, such as online real estate sites, is to return several items (in this instance, properties) that best meet users' requirements. This is a challenging task because it is crucial to show good items for *everyone* in a limited space, such as a web page. For instance, one user prefers a reasonably priced house while another one prefers a house located close to a station, a relatively expensive location. A classic retrieval approach is to focus on a single attribute such as price, but items generally contain multiple attributes and users rarely consider single attributes in their searches, thus raising the question: how does one display a set of options that can attract as many users as possible?

"A top-k dominating query can return a set of intuitively good options, and anyone can use it because it does not require any prior knowledge," says Takahiro Hara. This "top-k dominating query" was developed for centralized databases. Hara added, "Adapting it to large-scale distributed environments is not simple, and when large amounts of data are distributed over several locations, it is difficult to efficiently process the query. One difficulty is derived from the fact that if only the local best options are pulled from each site, a single option that is better than many options at another site might be missed." In their recent article published in *IEEE Transactions on Knowledge and Data Engineering*, researchers from Osaka University present a fast solution that incrementally explores the data space and places virtual points in it to ignore unnecessary points.

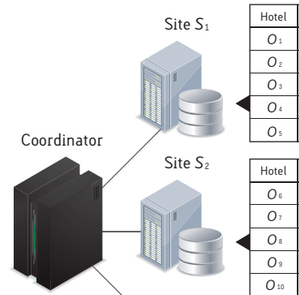
The space-filling approach leverages virtual points so that the algorithm can ignore irrelevant regions and focus on regions with high-scoring options. Fewer options are considered, meaning the final result can be returned as soon as it is identified. The researchers also proposed two approximate space-filling algorithms that emphasize speed over accuracy. "These algorithms can be better for buyers who want a good result but do not like to wait," says Hara.

"Space-filling algorithm uses virtual points to quickly find the best options"

Researchers develop a new way to enable e-commerce and web services to quickly return a set of the best options from large-scale distributed databases

The exact and approximate space-filling algorithms return results up to 10 times faster than existing methods. Even when over several million options are considered, returning results takes less than a few seconds.

As distributed environments grow in size and computation time decreases, adapting big data analysis methods to these environments is the key to enabling e-commerce and web services to provide answers efficiently in the future.



Hotel	Price [$/night]	Dist. to the NN station [m]
O_1	65	400
O_2	75	300
O_3	155	260
O_4	175	250
O_5	200	200

Hotel	Price [$/night]	Dist. to the NN station [m]
O_6	85	225
O_7	100	125
O_8	300	130
O_9	350	285
O_{10}	400	50

Hotel	Price [$/night]	Dist. to the NN station [m]
O_{11}	75	80
O_{12}	145	350
O_{13}	190	290
O_{14}	225	90
O_{15}	450	35

Features of hotel data held by distributed sites

[reference]

Amagata D. Hara T. Onizuka M. (2018) Space filling approach for distributed processing of top-k dominating queries. *IEEE Transactions on Knowledge and Data Engineering*. 30:6. DOI: 10.1109/TKDE.2018.2790387

https://resou.osaka-u.ac.jp/en/research/2019/20190308_e1

Masakatsu Murakami

Theory for Laser Plasma, Institute of Laser Engineering

Laser pulse compression technology invented in the late 1980s developed high-power short-pulse laser techniques, enhancing laser intensity 10-million-fold in a quarter of a century.

Scientists at Osaka University discovered a novel particle acceleration mechanism called 'micro-bubble implosion,' in which super-high energy hydrogen ions (relativistic protons) are emitted at the moment when bubbles shrink to atomic size through the irradiation of hydrides with micron-sized spherical bubbles by ultraintense laser pulses. Their research results were published in *Scientific Reports*.

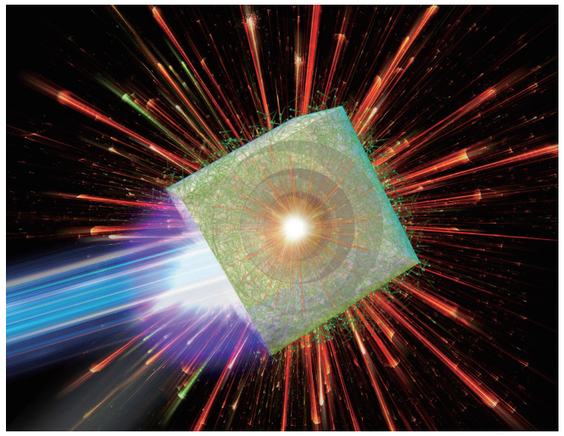
The group led by Masakatsu Murakami has reported an astonishing physical phenomenon: when shrinking matter to the unprecedented high level, with density comparable to matter the size of a sugar cube weighing more than 100 kg, high-energy protons are emitted from the positively-charged nanoscale clusters, a world first. Usually, an acceleration distance of several tens to hundreds of meters is necessary for conventional accelerators to generate such huge energy.

In micro-bubble implosion, a unique ion motion in which ions (charged particles) converge to a single point in space at half the speed of light plays a crucial role. This phenomenon, which looks like the opposite of the Big Bang, is essentially different from any previously discovered or proposed acceleration principles.

This new concept will clarify unknown space physics of grand scales of time and space, such as the origins of high-energy protons moving about in stars and space. In addition, as a compact source of neutron radiation through nuclear fusion, this concept will be utilized in a variety of applications in medical treatment and industry in the future, such as proton radiotherapy to treat cancer, the development of new energy with laser nuclear fusion, cross-sectional photos for developing fuel cells, and development of new substances.

"Could a particle accelerator using laser-driven implosion become a reality?"

Scientists discover new particle acceleration by micro-bubbles



Schematic view of a bubble implosion, which is a conceptual image showing the integration of all major events, i.e., laser illumination, hot electron spread, implosion, and proton flash.

[reference]

Murakami M. *et al.* (2018) Generation of ultrahigh field by micro-bubble implosion. *Scientific Reports* 8:7537. DOI:10.1038/s41598-018-25594-3

http://resou.osaka-u.ac.jp/en/research/2018/20180524_1

Kentaro Terada

Department of Earth and Space Science, Graduate School of Science

Understanding the origin and time evolution of near-Earth asteroids (NEAs) is an issue of scientific interest and practical importance because they are potentially hazardous to the Earth. However, when and how these NEAs were formed and what they suffered during their life-time remain enigmas.

Japanese scientists, including those from Osaka University, closely examined particles collected from the asteroid Itokawa by the spacecraft Hayabusa, finding that the parent body of Itokawa was formed about 4.6 billion years ago when the solar system was born and that it was destroyed by a collision with another asteroid about 1.5 billion years ago. Their research results were published in *Scientific Reports*.

Focusing on a few micrometers of phosphate minerals, which are rarely found in Itokawa particles, the scientists performed precise isotope analyses of uranium (U) and lead (Pb) in Itokawa particles of about 50 μ m in diameter using Secondary Ion Mass Spectrometry (SIMS).

Lead author Kentaro Terada says, "By combining two U decay series, ^{238}U-^{206}Pb (with a half-life of 4.47 billion years) and ^{235}U-^{207}Pb (with a half-life of 700 million years), using four Itokawa particles, we clarified that phosphate minerals crystalized during a thermal metamorphism age (4.64 ± 0.18 billion years ago) of Itokawa's parent body, experiencing shock metamorphism due to a catastrophic impact event by another body 1.51 ± 0.85 billion years ago."

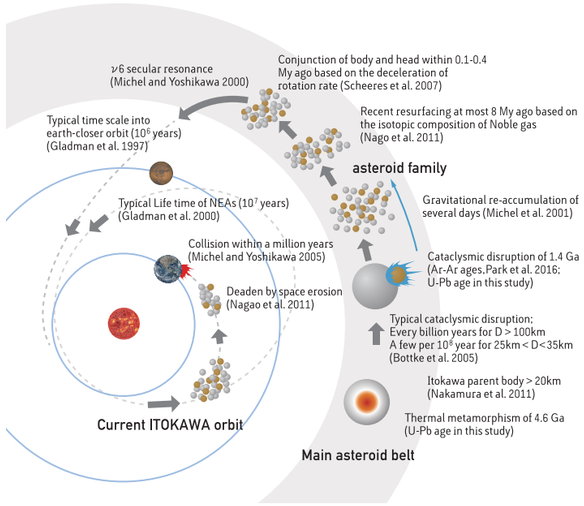
It has been reported that the mineralogy and geochemistry of the Itokawa particles resemble those of LL (LL stands for Low (total) iron, Low metal) chondrites, which frequently fall to the Earth.

However, the shock ages of Itokawa particles obtained from this study (1.5 billion years ago) are different from previously reported shock ages of shocked LL chondrites (4.2 billion years ago). This shows that the asteroid Itokawa had a time evolution different from that of the parent body of LL chondrites.

The results of this study established constraints on the timescale of the first samples collected from the asteroid, providing concrete figures (absolute age) to the evolution of the NEAs whose orbits are well known. This will lead to the elucidation of the origins and histories of asteroids.

"Particles collected by Hayabusa give absolute age of asteroid Itokawa"

Japanese research group clarifies the chronology of near-Earth asteroid 25143 Itokawa



The time evolution of the asteroid Itokawa

[reference]

Terada K. *et al.* (2018) Thermal and impact histories of 25143 Itokawa recorded in Hayabusa particles. *Scientific Reports* 8:11806. DOI:10.1038/s41598-018-30192-4

https://resou.osaka-u.ac.jp/en/research/2018/20180808_1

11

Humanities and Social Science

Tetsuya Matsubayashi

The Osaka School of International Public Policy

Numerous studies have found that lowering national legal drinking ages has myriad negative socioeconomic and health consequences. These include rises in frequency and amount of alcohol consumption, greater use of health services, and more fatal accidents. However, such studies have largely been in Western countries. As Japan has considered reducing its drinking age in line with the planned change of legal adulthood from 20 to 18, it has limited guidance in a local context.

Recently, Tetsuya Matsubayashi and Kanako Yoshikawa at the Osaka School of International Public Policy sought to lend direction to the debate and shed more light on the impact of the legal drinking age. They reported their findings in the *Journal of Studies on Alcohol and Drugs*.

One key premise underpinning their work was Japan's characteristic drinking patterns in society. For instance, among advanced nations, Japan has comparably lower alcohol consumption and fewer alcohol-related traffic deaths. The difference is especially notable regarding underage drinking.

"Japan's rates of underage drinking are far lower than in Europe and the US," the authors say. "We have to consider, if the current minimum legal drinking age of 20 keeps rates low, then removing it could considerably increase those rates. Another view is that drinking is just not that popular among younger Japanese, so lowering the age may have little impact."

The researchers performed two studies to examine the issue.

In the first study, they extracted records of intoxication-related emergency service use in Tokyo by those aged 18 to 21—i.e., around the legal drinking age—and compared them. The findings clearly showed that a legal drinking age of 20 led to a twofold increase in alcohol-intoxication-related emergency events for those who could legally drink. Men also showed a slightly higher use rate than women.

"Wait until you're 20: Little benefit seen in lowering Japan's drinking age"

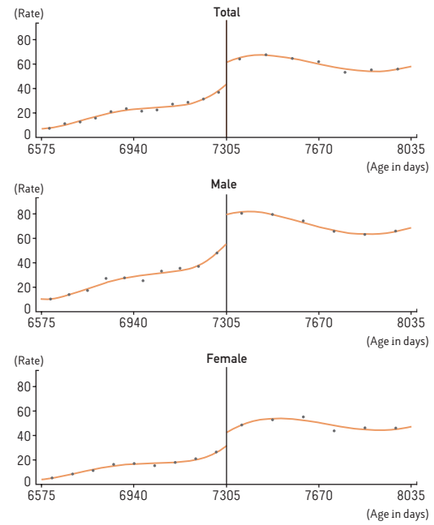
Researchers find that lowering Japan's legal drinking age from 20 to 18 would likely increase excessive drinking but have little impact on mortality

In the second study, they examined death certificate records in Japan, again focusing on people around age 20, and alcohol-related causes of death. These causes included motor vehicle fatalities, suicide, and accidents such as falling, drowning, and choking. Here they found the drinking age had no statistically significant impact, mostly notably regarding motor vehicle accidents, which is contrary to some previous studies.

Despite the clear evidence of a strongly positive relation between drinking age and emergency service use (thus, excessive drinking), and thereby a likely negative impact on college students' academic performance, The authors say the findings' policy implications are nuanced.

"The correlation between excessive drinking and emergency service use was clear," he says. "However, as we found no immediate negative impact on mortality by external causes, some may argue that lowering the drinking age could allow new intervention by government such as design of earlier education programs on alcohol at school. The government should be cautious and look at all angles if it considers lowering the drinking age."

Discontinuities in emergency service for alcohol intoxication



Note: The binned average values of the rate of emergency service event for alcohol intoxication were plotted against age in days. The curved lines denote the fitted values from fourth-order polynomial regression functions estimated separately on each side of the cutoff point. The vertical line indicates the cutoff point.
Source: Emergency Service Database, Tokyo Fire Department.

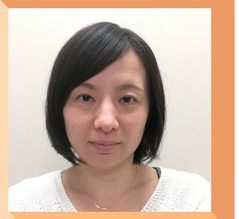
[reference]

Matsubayashi T. and Yoshikawa K. (2018) Minimum Legal Drinking Age and Youth Health: Evidence From Japan. *Journal of Studies on Alcohol and Drugs* 79:4, 539–54 DOI: 10.15288/jsad.2018.79.539

https://resou.osaka-u.ac.jp/en/research/2019/20190308_e2

12

Humanities and Social Science



Sachi Takaya

Graduate School of Human Sciences

It's been 30 years since migrant workers in Japan, called *newcomers*, first started getting attention. Over the years, an increase in their numbers has brought to the forefront issues such as education and labor. Osaka, one of the largest metropolitan areas in Japan, boasts a rich history of minority movement where via active participation the parties concerned take political action themselves to tackle issues such as poverty and discrimination. Such a practice by Korean residents in Osaka has also resulted in a situation where political action has been taken by the local government to include minority communities into the mainstream.

Not surprisingly, Osaka offers a good example for understanding the contours of such a participation model, and that is why her current project aims to understand the dynamics between an Osaka-type participation model initiated by the minority and policymaking for tackling minority poverty and discrimination.

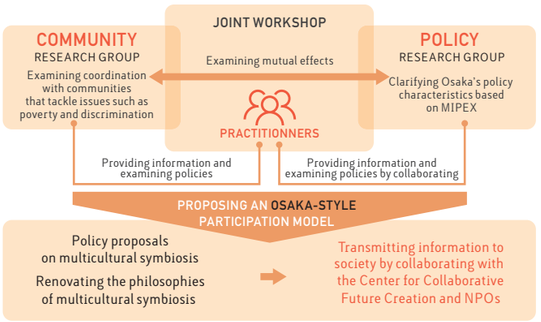
Yet, even though Osaka has been active in bringing about "*tabunkakyosei*," a working model for multicultural symbiosis, Japan overall has been a "latecomer." Until very recently, the Japanese government officially only accepted skilled professionals from specialized and technical fields while barring unskilled labor; yet, under what has been labeled a "side-door" scheme, it has been accepting foreign students and technical intern trainees who are then employed under conditions that made them susceptible to exploitation. In fact, the 2018 revisions to the Immigration Control and Refugee Recognition Act emphasized that it was "not a migration policy" drafted to bridge the opposing opinions of an industrial realm that wants cheaper labor and conservatives who have traditionally been unreceptive toward migrants. Takaya has investigated and articulated the rationale that prescribes Japan's migration policy with the "liberal trilemma" of economic liberalism, political liberalism, and international human rights—each often at odds with the others. Thus, she believes that the latest reform to immigration law should not be mistaken for a migration policy but instead as a labor policy meant to utilize foreign personnel.

In this context, she also believes her ongoing study of the Osaka model may be able to shed light on multicultural symbiosis that is not exploitative and can be expanded nationwide. Specifically, showcasing the Osaka model in her research will suggest the best practices on how to incorporate *newcomers* in society via changes to laws governing local community participation.

"Migration and community participation"

Searching for a working model for multicultural symbiosis

Characteristics of the Research Plan



[reference]

TAKAYA S. ed., forthcoming, *What makes a migration policy?: Thinking through the realities of Japan*, Kyoto: Jimbunshoin. (in Japanese)
TAKAYA S. 2018, "Why hasn't established the official migration policy?: Migration politics and liberal trilemma in Japan," *Social Theory and Dynamics*, 10: 58-77. (in Japanese)

https://resou.osaka-u.ac.jp/en/research/2019/20190308_e3