

# ANNUAL REVIEW 2016

TOHOKU UNIVERSITY

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# History of Tohoku University

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For more than a century, Tohoku University has embraced its role of not just grooming the next generation of leaders, but also arming them with the most innovative technology that the world's best research teams can produce.

And it achieved this by following the three tenets that have defined the university since its founding in 1907 – Research First, Open Doors and Practice-oriented Research and Education.

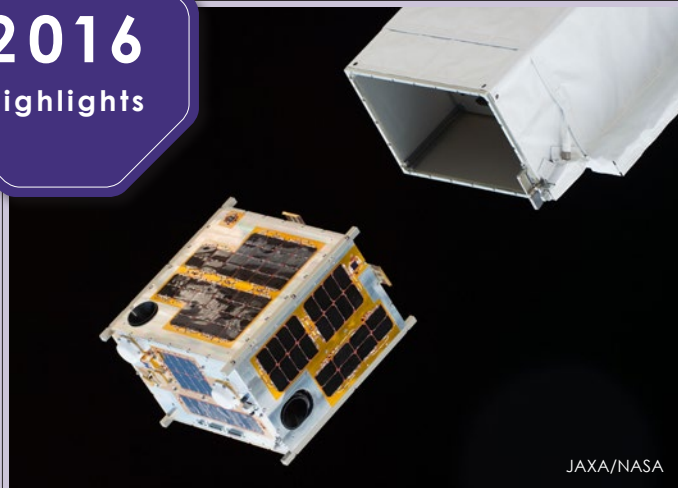
Since the very beginning, the university's Open Door policy has allowed it to tap valuable human resources. Departing from the norms of other imperial universities at the turn of the century, Tohoku University accepted graduates from technical schools. And in 1913, it went a step further and – despite opposition from the government – became Japan's first university to accept female students.

Over the years, the university has been successful in attracting brilliant researchers from around the world. Following a Research First policy, these scholars pursued productive research and put their findings to work in the teaching of their students. This led to the spirit of Practice-oriented Research and Education that the university has become famous for.

Building on these three ideals, Tohoku University has consistently tried to use its research success to address both local and global problems.

Since the 2011 Great East Japan Earthquake, the university has been providing expertise and support to the region through technological development and reconstruction efforts. Six years on, Tohoku University remains committed to the recovery of the region.





## DIWATA-1 Microsatellite

Tohoku and Hokkaido Universities successfully guided nine Filipino engineers in building the Philippines' first microsatellite, as part of a collaborative research contract with the Philippines Department of Science and Technology. The 50kg DIWATA-1 microsatellite, was successfully released into orbit from the Japanese Experiment Module Kibo on the International Space Station on April 27, 2016.

## IMPACT-Tough Robotics Challenge

Members of the government's Tough Robotics Challenge programme conducted field tests at Aobayama Campus, showcasing newly developed rescue robots that can function in hostile environments and support humans during a disaster. These included the Active Scope Camera Robot, Construction Robot, drones and cyber rescue canines.



## Tohoku University Day in Melbourne

Tohoku University and the University of Melbourne signed a new academic exchange agreement, which will further encourage student and faculty mobility between the two institutions. In November, Tohoku University Day hosted by the University of Melbourne featured a 2-day Research Workshop on Materials Science.

## APRU-IRIDeS Multi-Hazards Summer School

Some 50 students and faculty members from 11 countries took part in the APRU-IRIDeS Multi-Hazards Summer School. Participants discussed the role of various stakeholders in disaster management and visited affected areas to better understand the reconstruction processes.



## International Festival

The Tohoku University International Festival continues to grow bigger and better each year, attracting thousands of participants from Sendai and across the prefecture. Highlights in 2016 included food, fun and games from more than two dozen countries. It was the perfect start to summer!

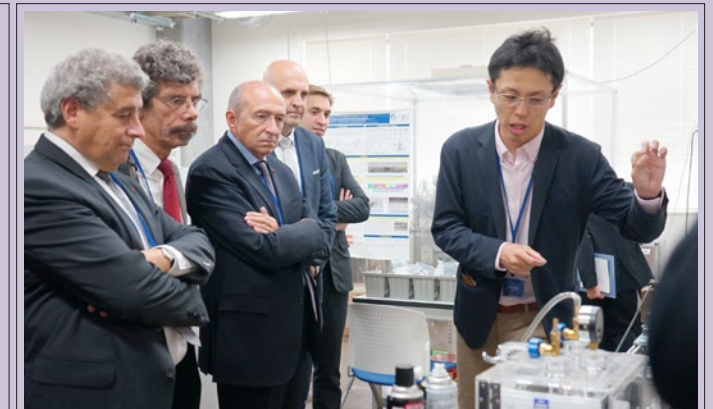


## Gender-neutral Toilets

Specially equipped toilets, which can be used by anyone, have been installed at Kawauchi's North Campus. The lavatories will benefit staff and students who identify outside of the gender binary, people with disabilities, and parents with children. By providing gender-neutral toilets, the university hopes to create a safe and inclusive campus environment for everyone. All-gender toilets will be accessible campus-wide in the near future.

## Russo-Japanese Academic Agreement

An agreement was reached between the Russian Federation and Japan, to have their institutions of higher education work more closely together. Tohoku University President Susumu Satomi and Moscow State University Rector Viktor Antonovich Sadovnichiy, representing their respective countries, signed a Memorandum of Understanding at a ceremony in Tokyo in December. Copies of the agreement were exchanged at the Prime Minister's Official Residence, where Japanese Prime Minister Shinzo Abe was hosting a visit by Russian President Vladimir Putin.



## ELYTMAX

Tohoku University, CNRS and Université de Lyon launched an international joint unit aimed at strengthening their collaborations in materials science and engineering research. Based in Sendai, the new laboratory is known as "Engineering Science Lyon-Tohoku for Materials and Systems under Extreme Conditions," or ELYTMAX. Fifteen members, half of them French, study the behavior of materials and systems, to better understand their reaction to complex stress, electromagnetic fields and deterioration over time.

## AEARU Web Technology and Computer Science Workshop

The 11th AEARU Web Technology and Computer Science Workshop was held at Aobayama Campus. The event focused on topics such as big data behind small apps, and making cloud computing infrastructure smarter.

## Shinkishi Hatai Medal

The Shinkishi Hatai Medal was established by the Pacific Science Association in 1966 to honour distinguished leaders in Pacific marine biology. It was named after Tohoku University's first professor of biology, Shinkishi Hatai, in recognition of his contributions to Pacific marine biology. From 2016, the medal will be jointly administered by Tohoku University and the Pacific Science Association. At a ceremony in Taiwan in June 2016, the medal was awarded to the president and professor of the National Taiwan Ocean University, Ching-Fong Chang.





## SCRUM: Tohoku University Volunteer Support Center



At the forefront of Tohoku University's student volunteer movement is SCRUM, a group established in June 2011, to raise the profile of the towns most affected by the Great East Japan Earthquake and create awareness of the recovery efforts there.

SCRUM occasionally collaborates with other organisations, like the Tohoku University Foreign Students Association (TUFSA), with whom it plans English language study tours. One such tour was the visit to Onagawa last summer.

Despite being devastated by the tsunami more than five years ago, Onagawa has reinvented itself as a vibrant and easy getaway for city dwellers in Sendai. There are new coffeehouses, restaurants, shops and even a train station designed by Pritzker Prize-winning architect Shigeru Ban.

"Many people have a negative image of disaster areas, but these areas would not recover if everyone keeps focusing on the sadness and pain," said Gekko Patria Budiutama from TUFSA. "Onagawa has been able

to move forward because it's been very positive and creative."

Together with another volunteer organization HARU, SCRUM also brought festive cheer to the residents of Yamamoto, in the form of a trick-or-treat activity at Halloween.

Volunteers accompanied some 30 children dressed up in Halloween costumes, on a walk around town. They visited homes and received candy from delighted residents.

"We often meet old people in these towns who talk about their grandchildren," said Nana Sato of SCRUM. "There are very few activities that children and the elderly can enjoy together, so we thought trick-or-treating at Halloween is perfect

because residents who are not mobile can also take part."

Even the winter weather did not put a damper on SCRUM's activity schedule, as members headed to Rikuzentakata at the year's end. There they helped residents with a reforestation project by making bamboo screens to protect planted seedlings. Students also talked with residents by having meals together and learned about their life after the disaster.

And on a more recent trip to Ishinomaki, SCRUM and about 16 international students – many of them muslims – promoted halal Japanese food, and introduced aspects of Islamic culture to the local community.

SCRUM is a student group within the Tohoku University Volunteer Support Center. They plan regular tours to Iwate, Miyagi and Fukushima Prefectures.

TUFSA is the Tohoku University Foreign Students Association, which provides support for the university's large and active international community.

HARU is a volunteer group specifically set up to help with the reconstruction of cities in Miyagi that were devastated by the 2011 earthquake and tsunami.



## Putting the Cheer in Cheerleading



Tohoku University's cheer squad or "oendan" (応援団) was formed in 1963 by students who wanted to support the sports teams competing at the annual National Seven Universities Athletic Games. There are now more than 40 members who make up three regular units - the cheer leaders, the pom-pom girls and the brass band.

A typical performance includes a spirited song by the band, dancing by the pom-pom girls, and an intensely rigorous routine by the cheer leaders, whose choreographed chants serve as both encouragement and a war cry at events. "The members look really cool and manly when they cheer. There is a lot of passion in our group," said Naoki

Takagishi, squad leader and a 3rd year science student.

Despite the entertaining nature of the performances, the cheer squad takes its duties very seriously. Based on the Japanese "budo," or martial arts, the squad has strict rules and members are expected to show unwavering discipline, respect, passion and endurance.

In fact, the cheer leaders have a training regiment that is as tough as that of the sports teams they support. In addition to practicing their cheer routines, the members do physical training, such as running in the Aobayama mountainside and climbing the stairs of a nearby shrine.

The squad has cheering duties most weekends, and train three other times a week - twice within their own units, and together as a squad every Tuesday. "It's hard work but it's also very satisfying because we are a team," said Kanae Matsushita, a 2nd year psychology student who is one of the pom-pom girls.

This sense of unity and team spirit extends beyond the squad. "We are close to each other and we are also close to the members of our sports teams because we spend so much time together at tournaments," said Hiromu Miyamoto, a 2nd year, chemical engineering student.

Between January and March when most sports are on hiatus, the cheer squad turns its attention to other university events such as graduation and entrance ceremonies, academic conferences and even exams.

"We just want to cheer for Tohoku University," said Takagishi. "If our support can motivate the sports teams to win, or our students to succeed, then the cheer squad feels like we have won too."





# Kyoko Sengoku-Haga

Professor, Department of Art History

## A Portrait of the Artist as a Historian

Kyoko Sengoku-Haga hails from Mino, a suburb of Osaka, best known for its proximity to the site of the 1970 World Expo. “For many in my generation, that event gave us the chance to see things we had never seen before. I think it made us all want to be part of the bigger world.”

The daughter of a concert pianist and a soprano singer, Sengoku-Haga grew up with a strong appreciation for the arts. When she was in elementary school, she attended weekly art classes at an atelier near her family home. Unbeknownst to her at the time, her teacher, Tsuyoshi Maekawa, was a famous artist from Japan’s influential Gutai group.

“I didn’t know he was famous until much later. To me, he was just a great teacher who would always have something interesting for us to sketch or make things with. Every week we learnt something new and it was really fun. I think my love for art started there.”

## The study of art

While a member of the art club in school, Sengoku-Haga realized that she preferred studying and analyzing other people’s art to creating her own. She was a particular fan of a weekly newspaper column about classical art history and found early inspiration there.

As she began her study of classical art at the University of Tokyo, Sengoku-Haga decided to spend a month in Europe. “I travelled around France, Italy and Greece, visited all the museums and just fell in love with Greece. I’m not Christian so Christian art is a bit heavy for me. But the ancient Greeks were polytheistic and their mythology is quite similar to what we have here in Japan, so I felt instantly connected to them.”

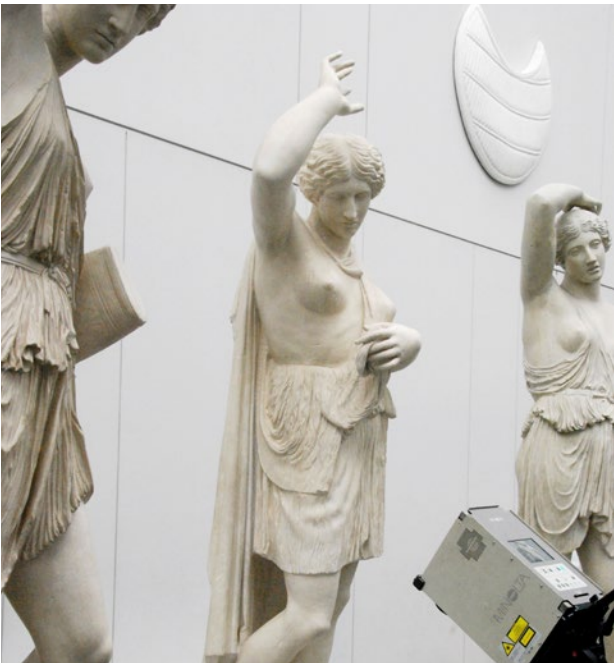
She later spent many more years in Europe, mostly in Greece, where she was a student at the Italian Archeological School in Athens. She also lived briefly in Rome and Munich, further honing her appreciation for classical art.

## The science in art

Now a researcher at Tohoku University’s Department of Art History, Sengoku-Haga has two professional goals - to raise the international profile of Japanese art historians, and to introduce classical European art to mainstream Japan.

At the center of her research is the technique of 3D shape comparison, which she came up with in 2007, and first published in 2010. Through the programme, scans of ancient materials can be compared with digital precision.

“The technique of carving was really precise in the ancient period. With 3D scanning, we can now say that two similar items have a difference of 1 mm here or 2 mm there. We can find differences that researchers could not see before, and with new information, we can hopefully learn more about the works and the sculptors.”



## The art in art

Closer to home, Sengoku-Haga’s attempts to make Greco-Roman art more accessible has led to two successful exhibitions in Japan - one on Greek art, and the other on Pompeii. She hopes that the exposure will encourage more young people to take an interest in the classics.

“Museums are wonderful places. When you travel, if you only see the tourist attractions and pretty landscapes, you can have a good time. But if you also go to the museums, you can truly understand the history of the place and the soul of the people.”



# Anawat Suppasri

Associate Professor of Tsunami Engineering Research  
Hazard and Risk Evaluation Research Division  
International Research Institute of Disaster Science (IRiDeS)

## Carried by the Waves

Anawat Suppasri speaks fondly of a childhood in Bangkok, Thailand, where he developed an early interest in Japan through video games and translated copies of Japanese comics. “I was a big fan of Rurouni Kenshin, Samurai X and stories about historical Japan. My biggest passion was Japanese castles.”

Despite his interest in history, he was encouraged to pursue a career in civil engineering at Chulalongkorn University when his parents noticed his aptitude for mathematics and numbers. “As a student, I thought I would be an engineer, stay in Thailand and work as a consultant in a firm after graduation. That was the plan.”

But in life, even the best laid plans are often changed by unexpected events. For Suppasri, they came in waves.

## 2004: Indian Ocean Tsunami

In 2004 – one year before Suppasri was due to graduate – the Indian Ocean tsunami devastated the coasts of Thailand



and much of South East Asia.

“No one expected it. We were totally unprepared, so many people were killed. I knew about tsunamis from the hydraulics class that I’d taken as part of my civil engineering course. I noticed that there was a lack of disaster engineers and tsunami experts in Thailand, so I thought that’s a gap I could try to fill.”

To that end, he pursued a master’s degree in water resource engineering at the Asian Institute of Technology, followed by a PhD in tsunami engineering at Tohoku University.

Then, history repeated itself.

## 2011: Great East Japan Tsunami

In response to the Great East Japan earthquake and the devastating tsunamis that followed, Tohoku University established the International Research Institute of Disaster Science (IRiDeS) in April 2012, and Suppasri became an associate professor at the Hazard and Risk Evaluation Research Division.

His current research focuses on tsunami numerical simulation, tsunami fragility analysis, tsunami evacuation and disaster mitigation education.

“After 2011, we were able to go to the disaster areas, see the trace - like mud and water marks - on the walls of the buildings. We measured the height of the flow depth and registered the extent of damage caused to the building. From this data, we can project what kind of damage a tsunami can cause under similar circumstances.”

Suppasri works closely with insurance companies and urban planners, who use his data for risk assessment, as well as a guide on how best to rebuild damaged cities.

Suppasri is also working with colleagues at IRiDeS to develop a mobile application for phones that can help non-experts interpret his data. “We’re trying to start an app that can give you tsunami information using the GPS in your phone. For example, if you are near the sea and you click on a nearby building on the map, the app will tell you if it is safe to go there based on information from the 2011 tsunami.”

## Beyond the waves

When not doing his own research, Suppasri helps out on the Yui Project, an IRiDeS initiative aimed at developing educational tools to help children learn about disaster mitigation. He also volunteers in disaster affected areas, and gives public talks at the request of the Royal Thai Embassy in Tokyo.

In rare moments away from work, Suppasri admits that the boy from Bangkok obsessed with samurais and Japanese history is still in him. Free time is in short supply but when he does find some, he enjoys travelling around the country, going to historical sites and yes, visiting Japanese castles.



# Global Education

## Exchange Programs

Tohoku University's popular exchange programs attract hundreds of new students each year from partner universities around the world.

In line with the importance the university places on research, the Junior Year Program in English (JYPE) and the graduate-level Cooperative Laboratory Study Program (COLABS) have, at their core, research oriented curricula that allow students to explore a wide range of topics in the field of science.

For the more arts inclined, there is the International Program in Liberal Arts (IPLA), which offers subjects such as economics, business, education, literature and intercultural communication.

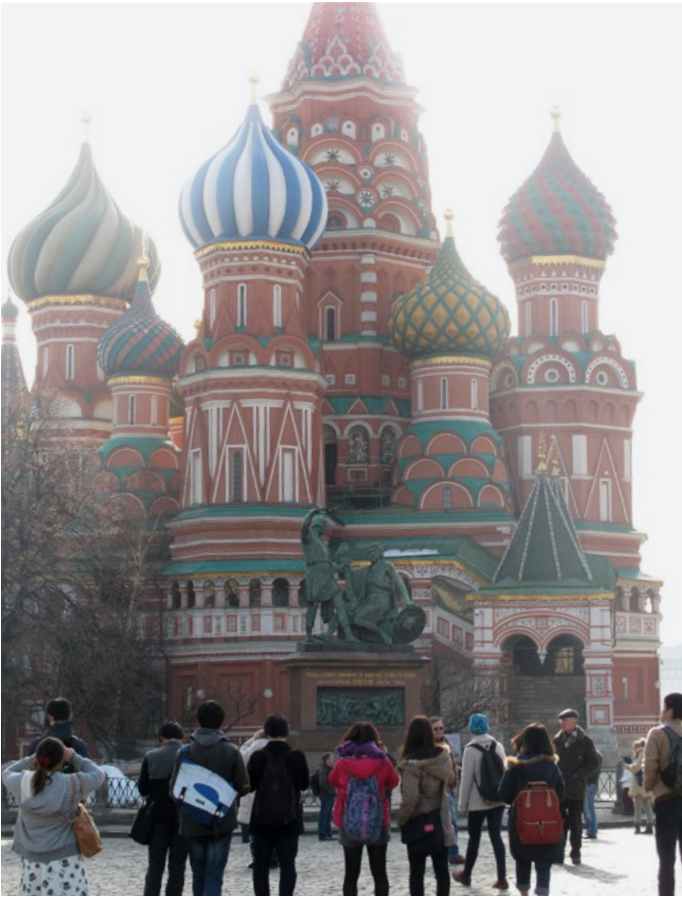
The programs include language classes and workshops, aimed at promoting the understanding of Japanese culture. Intellectual exchanges between professors and students, as well as hands-on participation in local festivals and community events, are integral parts of the exchange experience.

In 2016, a new Direct Enrollment Education Program



for the humanities and social sciences (DEEP-Bridge) was started. Participants take Japanese language and co-learning classes alongside local students, and must have at least N3 of the Japanese Language Proficiency Test.

In addition to students coming here, there is an increasing number of local students keen to go abroad. Tohoku University offers various short-term programs, double degree programs and faculty-led study abroad programs.



## Support Programs

Being far away from home can be daunting. Tohoku University is aware of the challenges faced by foreign students and have many support programs in place to help.

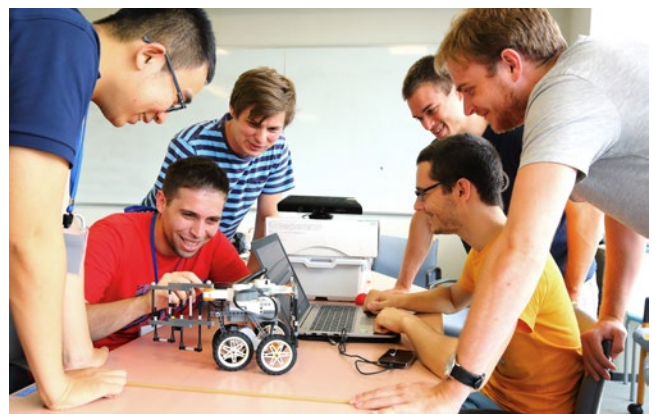
Orientation sessions specifically for international students are held twice a year to introduce campus facilities and services such as health care, counselling and career support. Community interest groups, reflecting both the university and the city's strong cultural diversity, also encourage international student involvement.

Tohoku University students interested in studying at the university's partner institutions get support in the form of biannual information sessions and scholarships. Staff at the Global Learning Center and study-abroad returnees also provide year-round counselling and advice.

At the grassroots level, the Tohoku University Foreign Students Association (TUFSA), @home and IPLANET offer logistical support to international students, as well as a lively social network. International students too, contribute greatly to the campus community through these organisations by sharing their native language and culture.







## Summer Programs

Summer is a great time to visit Tohoku University for the wide range of special programmes offered.

The Tohoku University Engineering Summer Program on Robotics (TESP) features two weeks of graduate-level classes taught by renowned professors. "It's an opportunity for students to get a nice overview, and to interact with other students and professors working in different technology and application fields. It's a good starting point for future collaborations," says Professor Kazuya Yoshida, coordinator of the programme.

In addition to robotics, an electrical engineering course

was offered for the first time in 2016, and the School of Engineering hopes to add a course on materials next.

At the undergraduate level, there is the Tohoku University Japanese Program (TUJP), which has become so popular that two sessions are held every year to accommodate the growing number of applicants. The program features classes on Japanese language, history, economy and the arts.

In 2016, a group project was added to the program, in which students were tasked with identifying challenges faced by the Tohoku region's tourism industry. In group presentations to city and tourism officials at the end of the fortnight, students offered solutions and ideas to improve the region's international appeal.





# Community Outreach @ Tohoku University

Throughout the year, Tohoku University connects with its wider community through workshops and events held on and around campus. It fosters university-community partnerships by providing public access to university expertise and resources.

## Ancient tomb scanned to preserve data

As part of Tohoku University's ongoing commitment to reconstruction and disaster management in the Tohoku region, researchers have collaborated with the local government in Futaba to collect data on a designated historical heritage site.

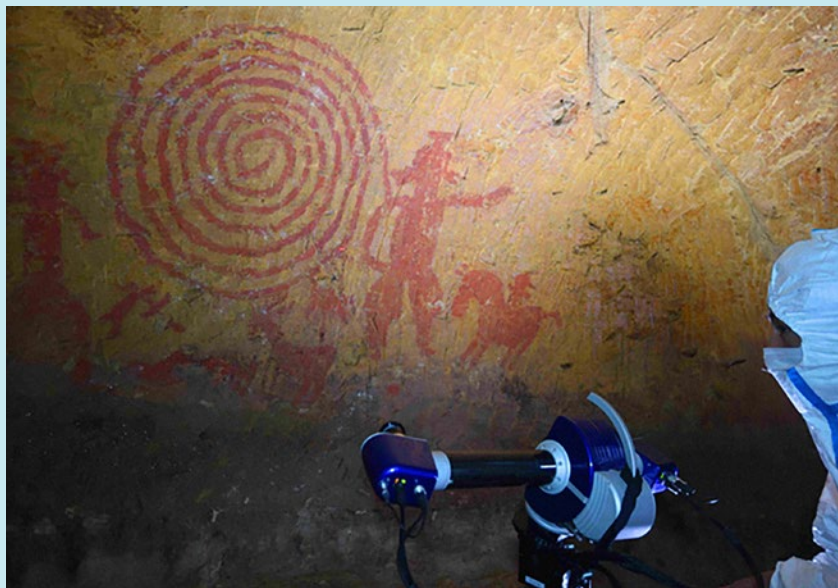
Located near the Fukushima no.1 power plant, the ancient burial chamber is in a difficult-to-return-to zone with radiation levels high since the nuclear incident in 2011. It dates back to the seventh century and contains a mural with a spiral pattern, animals and people on horses painted in red.

Archaeologist Atsushi Fujisawa, from Tohoku University Museum, mapped the tomb with a 3D scanner to collect data on its size and shape, as well as the artwork within. Fujisawa

said it was important to collect accurate data as the tomb is a valuable cultural asset.

Documenting and preserving

cultural heritage is an important issue around the world, especially in war-zones and in areas prone to natural disaster.



## Free cups of tea in exchange for rubbish

Researchers from the Graduate School of Agricultural Science have created a café with a twist. Locals at Naruko Hot Springs can visit the eco-friendly café and enjoy a free cup of tea, but only after handing over some of their kitchen waste. The organic matter is fermented to become biogas which is in turn used to boil water for the tea. This renewable source of energy can also be used as a liquid fertilizer on crops. The project aims to educate people on green energy while building community ties.



## International students promote fun and compassion

International students at Tohoku University make their mark on Sendai's community by promoting cultural diversity through events held throughout the year. The Water Colour Festival, organised by Tohoku University's Foreign Students Association (TUFSA), is held at the height of summer along the banks of Sendai's Hirose river. The festival's origins lie in the Indian Holi Festival which aims to bring people of all walks of life together to foster tolerance and celebrate the harvest.



## YUI Project

Tohoku University has been bringing disaster awareness to elementary schools through the YUI Project, which teaches children the basics of natural disasters and what to do in an emergency. The project is called YUI - which in Japanese means unity - because it focuses on the importance of community ties in disaster management.

Since beginning at Tohoku University in 2014, the project has reached children across Miyagi, Iwate and Fukushima prefectures.

## School kids learn from NASA expert

The Tohoku Forum for Creativity (TFC) invites distinguished researchers from around the world to share their expertise in the form of special lectures.

Last July Dr. Mike Zolensky from NASA's Johnson Space Center joined the TFC's "Earth and Planetary Dynamics" programme and spoke on planetary exploration to summer school participants. Together with Prof. Tomoki Nakamura from Tohoku University's Department of Earth Science, Dr. Zolensky also held a public talk at the Sendai City Science Museum for local school children, explaining the importance of sample return missions in unlocking the mysteries of the universe.





# Taking Memory for a Spin

Hideo Ohno is developing big impact technology at the nanoscale

***Surprise discoveries by Hideo Ohno have led to spintronic technologies that are set to drastically cut the power consumption of memory devices.***

In 2014, Hideo Ohno and his team at Tohoku University fabricated the smallest spintronic device, with a diameter equivalent to the thickness of a cell membrane (11 nanometers) and made up of layers the thickness of a sugar molecule (1 nanometer).

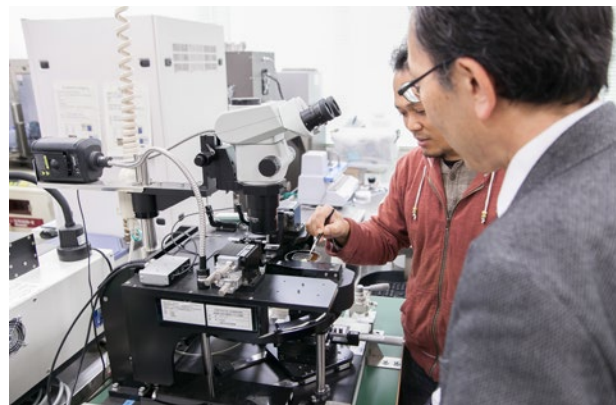
The minuscule technology featured capabilities considered vital for next-generation computer memories and integrated circuits - it ran on very little power and could store information even without a power source.

It had taken Ohno's team years of searching for the right materials and developing appropriate processing technologies to reach that point. At the nanoscale, even something as simple as measuring a device's diameter can prove challenging, says Ohno. "An electron micrograph of the device looks like Pluto billions of miles away."

But the world of nanoscale spintronics has captivated Ohno for close to three decades now. "The thing that fascinates me most about spintronics is that there has been a constant flow of new discoveries, surprises that we never could have anticipated."

## Among giants

Conventional electronics involve shunting electrical charge in the form of electrons around circuits. In contrast, spintronics exploits another property of electrons that has hitherto been ignored - their spin. Harnessing electron spin promises many benefits, including making devices faster and



less power hungry. Ohno's research involves combining the semiconductor technology of conventional electronic devices with magnetic spintronic devices to make efficient, high performance integrated circuits.

***Harnessing electron spin promises many benefits, including making devices faster and less power hungry.***

He sees himself as following in the footsteps of two "giants" at Tohoku University - Junichi Nishizawa and Shunichi Iwasaki. Nishizawa is known in Japan as 'Mr. Semiconductor' for inventing the three most important components underlying optical fiber communication (the PIN junction, laser diode and optical diode). While Iwasaki invented perpendicular magnetic recording, a technology now universally used in hard drives.

When Ohno first began his research in the late 1980s, semiconductor technologies and spintronics were worlds apart and hard to reconcile. While most integrated circuits are made of semiconducting materials such as silicon or gallium arsenide that are nonmagnetic, mass storage devices are made of magnetic materials with crystal structures that are incompatible with these semiconducting materials. "I wanted to integrate the two by making magnetic semiconductors that could be used in devices," explains Ohno.

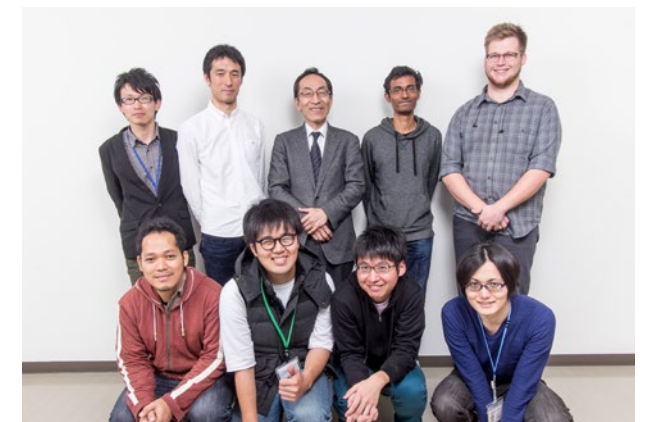
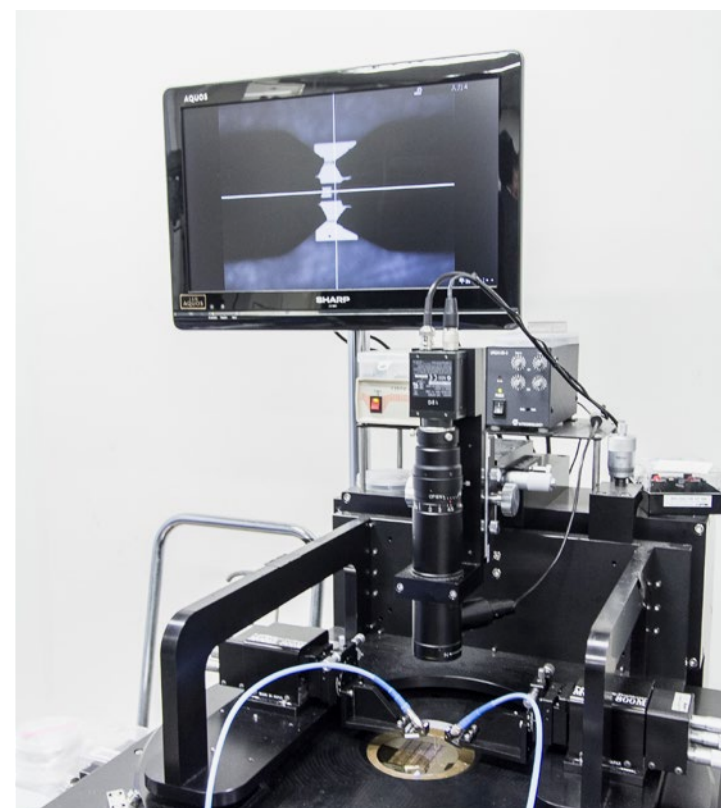
By adding the magnetic element manganese to gallium arsenide, Ohno succeeded in 1992 in creating material that was both semiconducting and had the magnetic properties of a permanent magnet known as ferromagnetism. "Making a material magnetic is different from making a material a magnet," explains Ohno. "But to my surprise, the semiconductor actually became a magnet (a ferromagnet) at low temperatures."

In 2000, he discovered a way to electrically manipulate the ferromagnetic properties of a semiconductor. And, in 2010, while further exploring the electric-field control of magnetic properties, Ohno's team found a way to magnetize the materials in a perpendicular direction - a finding that led them to develop the smallest spintronic device. The breakthrough came when the team discovered that they could achieve similar effects on magnetic metals as they could on magnetic semiconductors.

## Retrieving memory

Ultimately, Ohno hopes to use spintronics to develop non-volatile memories that retain recorded data even when no power is supplied to them. Such memories are currently available as flash drives and hard-disk drives, but are yet to be incorporated in integrated circuits.

Non-volatile spintronics memory based on a type of spintronic device known as magnetic tunnel junctions can also dramatically reduce the power consumption of computing and data storage. Ohno's smallest spintronic device was a magnetic tunnel junction.



"Data centers, such as those established by Amazon, Facebook and Google, are very power hungry," says Ohno. Much of this power consumption arises because power has to be supplied to volatile memories even when they're not being accessed. "Only about 10 percent of memory and logic is active at any time; the remaining 90 percent is awaiting instructions, but you still have to supply it with power," says Ohno. In contrast, since Ohno's memory devices are non-volatile, they do not require power when idle.

Tokyo Electron, the third-largest semiconductor manufacturer in the world, has taken a keen interest in the research being done at Tohoku University, and has donated a state-of-the-art clean room. "Tohoku University is the only university where you can experiment with 300-millimeter silicon wafers and get results with spintronic components combined with ordinary semiconductor transistors," Ohno says, referring to the industry-standard wafers used by major chip manufacturers.

In February 2015, Tohoku University signed an agreement with Johannes Gutenberg University of Mainz to establish a joint-degree program for PhD researchers in the field of spintronics. Ohno is excited about the potential of spintronics and what will be discovered next. The only thing he is absolutely certain of is that there will be many more surprises.

Hideo Ohno is the director of the Research Institute of Electrical Communication at Tohoku University. He is a professor of Spintronics.







Research Highlight

## Brain Buster

Noriko Osumi is uncovering the links between genetics and brain development

*The human brain is sometimes described as the most complex structure in the known universe. It's something we know surprisingly little about, even in 2016.*

One of the explorers of this scientific frontier is Noriko Osumi, a professor at Tohoku University's Department of Developmental Neuroscience. She's fascinated by everything brain-related – from how brains have evolved through time, to how they develop in the womb. Her research is centered on highlighting the connections between the growth of brain

cells, and both behavior and developmental disorders.

### Benefits of omega-3

Osumi and her colleagues recently showed that when pregnant mice consumed more of a fatty acid known as omega-6, often found in oils used in deep-fried food, and less of another known as omega-3, which is abundant in fish, they gave birth to pups with smaller brains.

Premature aging of fetal neural stem cells was believed to be involved. Furthermore, the pups exhibited abnormal

behavior such as high levels of anxiety after they grew into adults even though they were fed a normal diet postnatally.

"The imbalance seen in the mice doesn't really occur in the everyday life of humans, but the study underscores the importance of omega-3 in fetal development," says Osumi. "Unfortunately, pregnant women sometimes avoid eating fish due to fears of toxins such as mercury."

***Osumi's research is centered on highlighting the connections between the growth of brain cells, and both behavior and developmental disorders.***

The research, published in the journal *Stem Cells*, was conducted using transgenic mice that can convert omega-6 to omega-3. Fatty acids are another interest of Osumi's because of their relationship to PAX6, an important master regulator protein that can control brain and eye development by switching other genes on and off. Osumi helped pioneer knowledge of PAX6 after finding a mutation in the gene in a rat pup born without eyes or a nose.

She made that discovery while doing post-graduate work at Tokyo Medical and Dental University. She now has more than 1,000 rats and mice to work with in her lab, where about 15 students, postdocs and assistant professors study brain development.

Her team is also interested in PAX6 as a risk gene for autism in combination with the effect of paternal age. Autism prevalence is now about 1 to 2 percent and researchers hope that a deeper understanding of the genetics and epigenetics

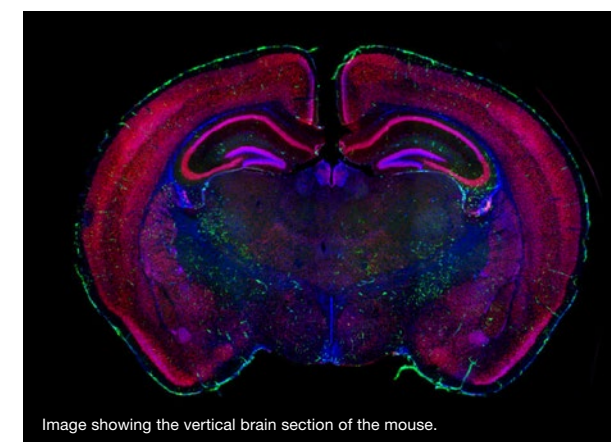


Image showing the vertical brain section of the mouse.



The developing brain inside a rodent's embryo

involved could lead to treatments.

"There could be some kind of solution because the underlying mechanism includes epigenetics," says Osumi, referring to the way gene expression can undergo change. "Some kind of epigenetic drug could be used on the father or during in-vitro fertilization. But we're talking about a future scenario."

### Biobank and genomic data

To reach those kinds of goals, Osumi is working with partners at the Tohoku Medical Megabank, a large-scale effort aimed at gathering samples from 150,000 people in the Tohoku region. It will focus on analyzing genomic data, particularly genes that cause diseases. One accomplishment so far has been the whole-genome sequences of 1,070 healthy Japanese and the compilation of a Japanese population reference panel known as 1KJPN. It could advance genomics-based medical care as well as identify genetic variants that can determine whether clinical treatments will help or harm a patient.

Osumi's work also involves collaborations across borders. The fatty acid study, for example, was done with fellow researchers in Canada and the U.S. Her lab participates in a scientific symposium held every year and a half. Participants include Tohoku University, the Japan Society for the Promotion of Science and the U.S. National Institutes of Health, which has hosted grad students from her lab.

"With collaborations, we get to have higher quality publications because of multiple minds working together. Most importantly, we meet and connect with people who will be a crucial part of our careers," says Cristine Casingal, a PhD student who recently joined Osumi's lab.

"Developmental neuroscience is new for me, but I know I will gain new knowledge and new techniques that will be beneficial in my future endeavors."

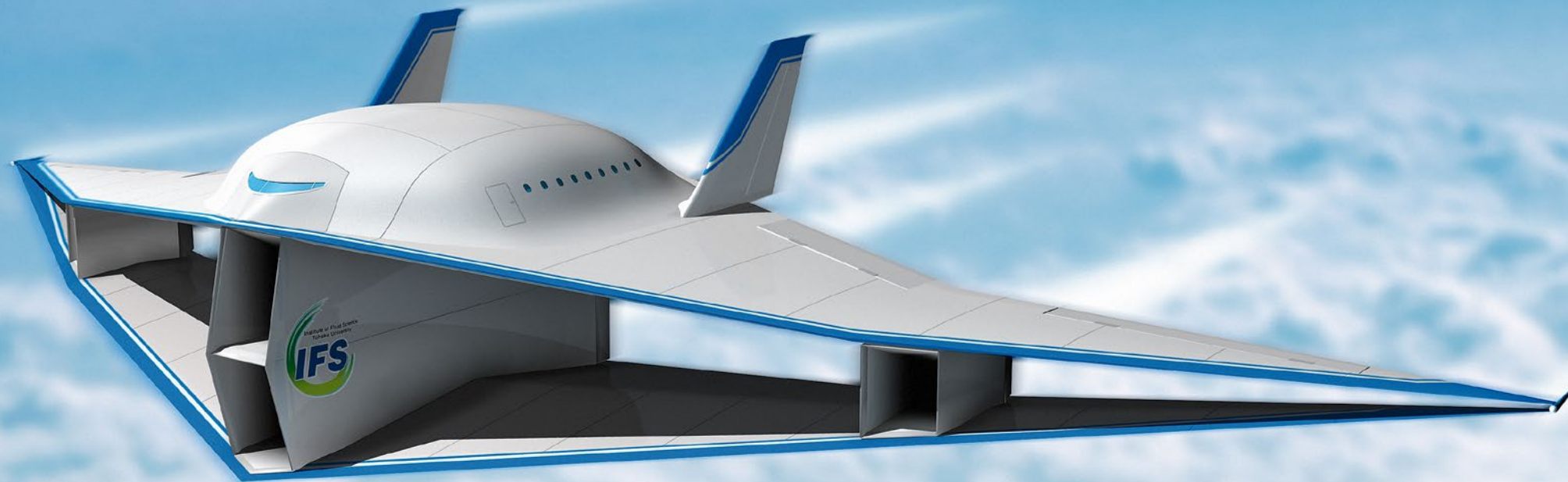
Noriko Osumi is the director of the Core Center for Neuroscience at Tohoku University. She is a professor of Developmental Neuroscience.





# Aiming High

Shigeru Obayashi is innovating human flight



***In March 2017, Boeing introduced the Max9 - the latest generation of its 737, a jet that has been in service for nearly 50 years. While cars gain artificial intelligence abilities and new fuel sources, it seems like airliners are evolving very slowly.***

Shigeru Obayashi is trying to change that by revolutionizing human flight. The director of Tohoku University's Institute of Fluid Science has been working on a design for a supersonic aircraft that would travel at Mach 2, halving the 12-hour flight time between Tokyo and New York.

## Supersonic jet

The Misora (MItigated SOnic-boom Research Airplane) Project is aimed at creating a supersonic plane that won't produce thunderous sonic booms, a major drawback that prevented Concorde from going supersonic over land; the last commercial supersonic plane was retired in 2003.

As a supersonic jet accelerates, it compresses the air in front and behind it, creating the shock waves that cause

sonic booms. Misora, which also means "sky" in Japanese, uses a biplane configuration that was originally proposed by German aviation engineer Adolf Busemann in the 1930s. The biplane's bottom wings are angled upward and the top wings are angled downward, leaving a large space in between for the passage of air. The setup makes the shock waves reflect



A cylinder is readied for a wind tunnel test by calibrating the position sensor on the test section of the Magnetic Suspension and Balance System, which can levitate objects for aerodynamic analysis.

built a small prototype of the biplane to demonstrate its airworthiness. They are also conducting tests on miniature models that travel at Mach 2 over short distances in a ballistic testing chamber on Tohoku University's Katahira Campus. In addition, they are performing experiments with a testing apparatus known as a magnetic suspension and balance system – the largest of its kind in the world – that helps measure airflow around an object while holding it in place with electricity and magnetic force.

***Faster is better for travel  
and business trips,  
but supersonic travel has  
to be economical  
for passengers  
and profitable for airlines.***

## Mitsubishi Regional Jet (MRJ)

Meanwhile, another Obayashi plane is already flying. In 2015, the Mitsubishi Regional Jet (MRJ) had its maiden flight, becoming Japan's first domestically produced passenger jet since the 1960s NAMC YS-11. Computer modeling techniques that Obayashi developed for the optimization of the flow of air around the wings and other parts, were used to improve the aerodynamic profile of the MRJ, which is expected to enter service in 2018.

"Roughly speaking, this airplane has 25 percent better fuel efficiency than existing planes," Obayashi says. "Half comes from its new engine, and half from Mitsubishi's design. Of that, 2 percent is from the optimization techniques."

The airflow optimization techniques have also been used to improve the aerodynamics of everything from washer-dryer fans to automobile tires to bullet train pantographs. Obayashi, though, is focused on Misora. The project faces many hurdles, including the lack of commercial supersonic activity, but he remains determined to see it get off the ground.

"We hope to have a full-scale prototype of Misora by 2050," he says. "The sky's the limit."



off the inside surface of the wings, reducing their effects on the ground by 85 percent.

"Faster is better for travel and business trips, but supersonic travel has to be economical for passengers and profitable for airlines," says Obayashi, who worked on Space Shuttle aerodynamics at NASA until the early 1990s. "The key thing is how much we can reduce the sonic boom."

Obayashi and the roughly 25 students in his lab have

Shigeru Obayashi is the director of Tohoku University's Institute of Fluid Science. He is a professor of Aerospace Fluid Engineering.







## Aobayama Campus Extends to New Heights

On the eve of its 70th anniversary, the Faculty of Agriculture moved from its aging premises at Amamiya Campus into state-of-the-art facilities at Aobayama Campus. The upgrade is part of a long-term project to create a hub of innovation in new fields of research and to increase academic-industry collaboration.

In 1947, two years after 20 percent of Sendai City was destroyed during World War II air raids, the Faculty of Agriculture was established at Tohoku University to help increase food production in the Tohoku Region. The campus was set up at Amamiya in downtown Sendai in 1949, out of existing buildings that had been used by Japan's former Second High School - a school that had traditionally fed into Tohoku University.

This remained the faculty's headquarters for more than 65 years. But with the buildings gradually deteriorating - compounded by



Guard house at Amamiya Campus

damage from the Great East Japan Earthquake - the university decided it was time to centralise its research bases. The newly-extended area of Aobayama Campus, with its customised educational facilities, became the Faculty of Agriculture's new home.

Last October, to thank the local community and alumni for all their support over the years, the Faculty of Agriculture held a Thanksgiving Festival at Amamiya Campus. The 3-day event featured public talks, stalls, club activities, photo exhibitions and sales of goods produced by the faculty - including home-grown blueberry jam and rice.

The relocation to their new home on the mountains of Aobayama took over six months. The administrative and research laboratories are now based out of the Multidisciplinary Research Laboratory for Agricultural Science.

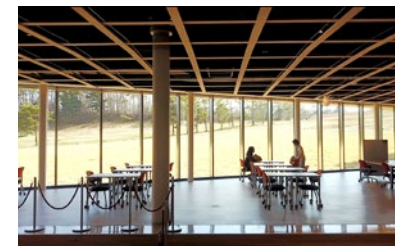
Two other main facilities are the



Agricultural Experiment Station

Animal Research Facility, used by students studying animal science, and the Agricultural Experiment Station, for plant science students. In addition to the facilities at Aobayama, the Faculty of Agriculture also conducts research out of field centers - the Terrestrial Field Station at Kawatabi and the Marine Station at Onagawa.

At the heart of the new extension is Aobayama Commons - home to the Faculty of Agriculture's main library, lecture theatres, a cafeteria, student health center and convenience store. The library has spectacular views



View from Aobayama Commons

overlooking the forest and an open green area, which will be known as Aobayama Park when completed.

Positioning the Faculty of Agriculture up alongside the Faculties of Science, Pharmacy and Engineering will make it easier for inter-disciplinary collaborations. With the new subway line opened since December 2015, the campus is now only a nine-minute ride from Sendai Station.

Tohoku University first established a campus on Aobayama in 1965 when the School transferred there from Katahira Campus. The new extension has been built on 81 hectares of land, once used as a golf course. It was

purchased by the university in 2006 and construction began two years later.

Facilities there now include the International Research Institute of Disaster Science (IRIDeS), the Center for Innovative Integrated Electronic Systems (CIES), the Research Center for Rare Metal and Green Innovation, as well as the Graduate School of Environmental Studies. It is also the centre of the university's academic-industry collaborations, which operate out of the New Industry Creation Hatchery Center (NICHe) and the Innovation Center for the Creation of a Resilient Society.

The new facilities are state-of-the-art and fitted with the latest in cutting-edge equipment. Even the architecture is designed with unique features relevant to each field of research. This includes a clean room at CIES, a solar chimney that generates natural air-conditioning at the Graduate School of Environmental Studies, earthquake-proof foundations at IRIDeS, and an indoor two-storey

purpose-built space for flying drones at the Research Center for Rare Metal and Green Innovation.

Centralizing the new research institutes is expected to accelerate technological innovation and make the area a major hub for research and development.

Not only will students and faculty benefit greatly from the upgraded facilities, but there is more to come. Due for completion in 2018, are university dormitories that will accommodate 752 students in single studio rooms. There will also be a restaurant, cafeteria and childcare centre built at the entrance of the new campus extension.





# Campus Report

There were significant changes to our campuses this year with the building of the Aobayama extension, and the closing of Amamiya. The new Aobayama extension includes facilities for the International Research Institute of Disaster Science (IRIDeS), the Center for Innovative Integrated Electronic Systems (CIES) and is the new home of the Faculty of Agriculture.



## Aobayama Campus

### Aobayama Station Plaza

At the entrance of the new extension is the Aobayama Station Plaza. Lush lawns surrounding the subway station's South Exit offer an attractive spot for outdoor events.

Rows of zelkova trees link the new walkway with the existing tree-lined street that runs down the East Campus. While an upgraded pedestrian path leads from the station's North 1 exit to the entrance of the North Campus.

### Aobayama Commons

Aobayama Commons, sitting at the heart of the extension, features a cafeteria, student health center, convenience store and the Faculty of Agriculture's main library. The lounge overlooking University Park provides a relaxing space for students to gather and study.



### Multidisciplinary Research

### Laboratory for

### Agricultural Science

The closure of the aging Amamiya campus last year meant a big move for the staff and students of the Faculty of Agriculture. The faculty's new premises at the Aobayama extension includes state-of-the-art research buildings, the Agricultural Experiment Station for farming activities and paddocks for livestock.



### Kawauchi Hall

The main addition to Kawauchi Campus this year is a new extracurricular activities facility known as Kawauchi Hall. The first two floors are for cultural activities, with rehearsal rooms and a mini-theatre that seats 120 people. The third floor has gyms for sports training, and a heated pool occupies the fourth floor. The environmentally friendly building features renewable energy solutions such as rooftop solar panels, which are used to heat the pool.

## Kawauchi Campus

### Kawauchi Station

The Tozai (East-West) subway line, which began operations last year, now provides more access to our campuses than ever before. The areas in front of the campus stations have also been built or refurbished with greater efficiency and safety in mind.

The Kawauchi Station Square, for example, is designed like a mini amphitheater with steps that double as seating for performances. Wheelchair friendly pathways also extend from the station to each level of campus.

Through the relocation of car and bicycle parking lots, the area in front of Kawauchi Station has been turned into an attractive promenade. The walkway is lined with zelkova and cherry blossom trees and uses permeable concrete to prevent stormwater runoff. This increases the greenery on campus, which in turn helps to control the heat in the summer.





# University Facts & Figures



Students **17,885**

Faculties	10
Graduate Schools	16
Research Institutes	6
International students	1,944

## Subway stops

**3**



Tohoku University's 4 main campuses in Sendai City are built on 2,896,574m<sup>2</sup> of land.

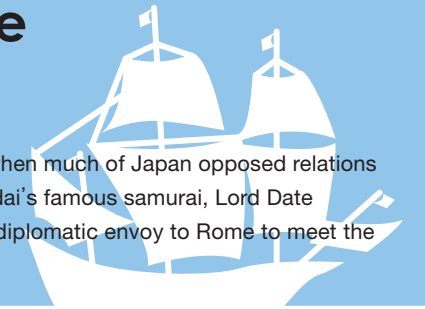
- Aobadori Ichibancho Station
- Kawauchi Station
- Aobayama Station

**Sendai → Tokyo**  
**1 hr 31mins** by bullet train



## To Rome

In 1613, at a time when much of Japan opposed relations with the West, Sendai's famous samurai, Lord Date Masamune, sent a diplomatic envoy to Rome to meet the Pope.



## Libraries

**20**

The main library houses:

- the largest collection of books and materials belonging to writer Natsume Soseki, one of the most influential writers of the Meiji period.
- woodblock prints by artist Utagawa Hiroshige.

## Cafés

**14**



## Public gardens

**2**



## Convenience stores

**9**



## Great East Japan Earthquake

On March 11, 2011 a magnitude 9.0 earthquake occurred off the coast of Sendai, triggering a mega-tsunami and a nuclear incident. Since the disaster, Tohoku University has initiated more than 108 reconstruction projects to support recovery in the region.

City		Dose of Radiation(uSv/h)	Date of measurement
Sendai		0.039	Dec. 31, 2016
Tokyo		0.031	Dec. 31, 2016
Paris		0.057	Oct. 29, 2015
London		0.092	Nov. 9, 2015
Beijing		0.071	Dec. 20, 2015
Seoul		0.117	Nov. 10, 2015
New York		0.058	Dec. 31, 2016

## Seasons

Summer is hot / Winter is cold



August **28.1°C**



January **1.5°C**

## City of Trees

Sendai is known as the City of Trees for its numerous parks



Cherry blossom



Zelkova



Ginkgo



Persimmon

## Museums & exhibition rooms

**7**



## Sports clubs & culture clubs

**77**



## Observatories

**8**



## Occasionally spotted on campus



bears



raccoons



pheasants



foxes



goshawks

## Festivals in Sendai

Aobamatsuri  
Tanabata

Streetjazz Festival  
Starlight Pageant







# Tohoku University's Alumni Association

Joining the Tohoku University Alumni Association is the best way to stay in touch with events on campus! The Alumni Association hosts four main events each year – Kansai, Kanto, Kyushu area and Premium members’ social gatherings. In addition to these, there are regional events run by local alumni organizations, as well as regular campus activities that all alumni are welcome to attend!

Homecoming Day is the largest alumni event on the annual calendar, with concerts and stalls throughout the day. It’s a chance for alumni to revisit the campus, meet with former teachers, friends and current students.

## Registering your alumni branch with the Alumni Association

If you are an alumnus of Tohoku University and have an alumni branch in your city or country, you can register your branch with the Shuyukai Alumni Association at no cost. Once registered with us we will post your contact information on our website, so that other alumni can be made aware of your activities.

Contact: [alumni@grp.tohoku.ac.jp](mailto:alumni@grp.tohoku.ac.jp)



## Office opens in Bangkok

In 2016, Tohoku University opened a new Overseas Office at Chulalongkon University in Bangkok, reflecting Tohoku University’s strengthening ties with partner institutions in Southeast Asia. The office serves to help recruit international students, support alumni groups and facilitate internship programs with local businesses.

Three other Overseas Offices are located in Beijing, Moscow and Novosibirsk.

# Contacts

Faculties / Graduate Schools	Research Institutes	University Facilities
<p><b>Faculty of Arts and Letters / Graduate School of Arts and Letters</b> E-mail: <a href="mailto:art-syom@grp.tohoku.ac.jp">art-syom@grp.tohoku.ac.jp</a> <a href="https://www.sal.tohoku.ac.jp/en/">https://www.sal.tohoku.ac.jp/en/</a></p> <p><b>Faculty of Education / Graduate School of Education</b> E-mail: <a href="mailto:sed-syom@grp.tohoku.ac.jp">sed-syom@grp.tohoku.ac.jp</a> <a href="http://www.sed.tohoku.ac.jp/~english/">http://www.sed.tohoku.ac.jp/~english/</a></p> <p><b>School of Law / Graduate School of Law</b> E-mail: <a href="mailto:law-jm@grp.tohoku.ac.jp">law-jm@grp.tohoku.ac.jp</a> <a href="http://www.law.tohoku.ac.jp/english/">http://www.law.tohoku.ac.jp/english/</a></p> <p><b>Faculty of Economics / Graduate School of Economics and Management</b> E-mail: <a href="mailto:eco-syom@grp.tohoku.ac.jp">eco-syom@grp.tohoku.ac.jp</a> <a href="http://www.econ.tohoku.ac.jp/econ/english/">http://www.econ.tohoku.ac.jp/econ/english/</a></p> <p><b>Faculty of Science / Graduate School 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href="http://www2.tagen.tohoku.ac.jp/en/index.html">http://www2.tagen.tohoku.ac.jp/en/index.html</a></p> <p><b>International Research Institute of Disaster Science</b> E-mail: <a href="mailto:irides-syomu@grp.tohoku.ac.jp">irides-syomu@grp.tohoku.ac.jp</a> <a href="http://irides.tohoku.ac.jp/eng/index.html">http://irides.tohoku.ac.jp/eng/index.html</a></p> <p><b>Institute for Excellence in Higher Education</b> E-mail: <a href="mailto:ieheoffice@ihe.tohoku.ac.jp">ieheoffice@ihe.tohoku.ac.jp</a> <a href="http://www.ihe.tohoku.ac.jp/index_eng.html">http://www.ihe.tohoku.ac.jp/index_eng.html</a></p> <p><b>WPI Advanced Institute for Materials Research (WPI-AIMR)</b> E-mail: <a href="mailto:aimr-soumu@grp.tohoku.ac.jp">aimr-soumu@grp.tohoku.ac.jp</a> <a href="http://www.wpi-aimr.tohoku.ac.jp/en/index.html">http://www.wpi-aimr.tohoku.ac.jp/en/index.html</a></p> <p><b>Tohoku Medical Megabank Organization (ToMMo)</b> E-mail: <a 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href="http://qsc.eng.tohoku.ac.jp/en/index.html">http://qsc.eng.tohoku.ac.jp/en/index.html</a></p>
Administration		
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# Welcome to Sendai, the City of Trees

Tohoku University's four main campuses are spread across the cosmopolitan city of Sendai, the cultural, political and economic center of Japan's northeast (Tohoku) region.

Located some 300 kilometers - and a short 90-minute bullet train ride - from Japan's capital, Tokyo, Sendai is a city of fascinating contradictions.

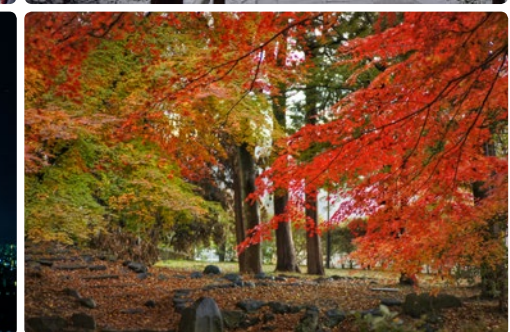
It's a big, sophisticated metropolis with museums and music halls, trendy shops and cafes, and a home team in every major professional sport. But it also has a small city charm, easy friendliness and magnificent nature. In fact, for its zelkova-lined streets and rivers that flow downtown, Sendai has the well-deserved nickname of Mori no Miyako, or the City of Trees. Through four distinct seasons, the city enjoys a temperate climate, with especially beautiful autumn colors and snow-covered landscapes in the winter.

A day trip away from Sendai are many of the region's other famous landmarks, such as Matsushima Bay, dotted with small islands, pine trees and oyster farms. Known as one of Japan's three most scenic locations, Matsushima even inspired the most famous poet of the Edo period, Matsuo Basho.

For the more athletic, nearby Mt. Zao is a popular ski and hot springs resort. It is also the best place to view the region's famous Snow Monsters in winter.

Sendai is home to a million people - many of whom are students and academics. Anchored by Tohoku University, the city boasts some of the top research facilities and institutes in the world. With a vibrant and energetic population, the city celebrates many colourful events throughout the year, while retaining many old traditions. The Aoba Street Festival, the Sendai Tanabata Festival, the Jozenji Streetjazz Festival and the winter Starlight Pageant are just examples of annual events that consistently draw visitors and participants from all over the country and across the globe.

Come join us in Sendai!



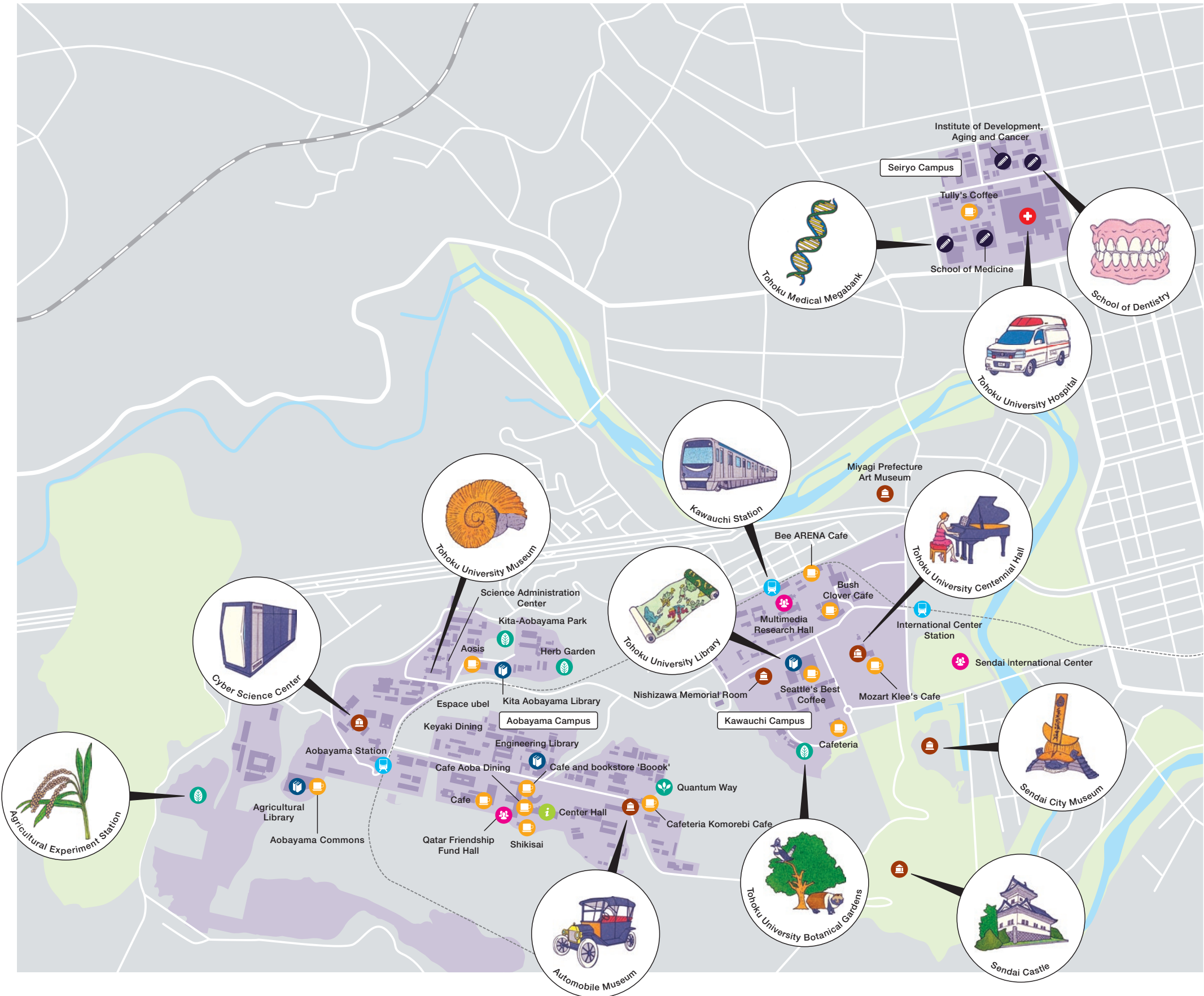


# In and Around Tohoku University

## Seiryō / Kawauchi / Aobayama Campus

Tohoku University's four main campuses are spread across the cosmopolitan city of Sendai.

- Medical
  - School of Medicine
  - School of Dentistry
  - Tohoku University Hospital
  - Institute of Development, Aging and Cancer
  - Tohoku Medical Megabank
- Museums / Memorials
  - Automobile Museum
  - Cyber Science Center Exhibition
  - Nishizawa Memorial Room
  - Quantum Way
  - Sendai Castle
  - Sendai City Museum
  - The Miyagi Art Museum
  - Tohoku University Museum
  - Tohoku University Kawauchi Hagi Hall
- Arts & Performance
  - Aobayama Station
  - Kawauchi Station
  - International Center Station
- Parks & Gardens
  - Botanical Gardens
  - Herb Garden
  - Kita Aobayama Park
  - Agricultural Experiment Station
- Libraries
  - Agricultural Library
  - Engineering Library
  - Kita Aobayama Library
  - Tohoku University Main Library
- Eateries
  - Aoba Dining
  - Aobayama Commons
  - Aosis
  - Bee ARENA Café
  - Bush Clover Café
  - Café and Bookstore 'Boook'
  - Espace Ubel
  - Keyaki Dining
  - Komorebi Café
  - Mozart Klee's Café
  - Seattle's Best Coffee
  - Shikisai
  - Tully's Coffee
- Conference & Event Venues
  - Qatar Friendship Fund Hall
  - Multimedia Research Hall
  - Sendai International Center
- Schools / Faculties
  - Center Hall
  - Science Administration Center





# Katahira Campus



- Eateries
- Ban Thai Lanna
- Café Mozart Atelier
- Kazunori Ikeda Patisserie
- Restaurant Alley - Iroha Yokocho
- Sakura Kitchen
- Sindur Indian Food
- Sightseeing
- Anagura Shrine
- Main Gate
- Otamayabashi Bridge
- Ryokusuian Tea House
- Yanagimachi Shrine
- Zuihoden
- Shopping Stores
- Meiji Foreign Goods
- Station
- Aoba-dori Ichibancho Station

- University Facilities
- Honda Memorial Room
- Lu Xun Lecture Hall
- Tohoku University Administration
- Tohoku University Archives
- Conference
- Katahira Kitamon Commons
- Sakura Hall
- TOKYO ELECTRON House of Creativity
- Accommodation
- Katahira Hall
- University House
- Parks
- Academic City Memorial Park
- Hyojogawara Baseball Field
- Katahira Park
- Komegafukuro Walkway
- ATMs
- Post Office

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