CHIBA RESEARCH

Highlights of innovative and collaborative research

CHIBA UNIVERSITY

University Library/Academic Link Center

Guided by its motto "Always aim higher," **CHIBA UNIVERSITY** strives to nurture globally minded students who have broad outlooks. The university values academic diversity and actively conducts leading-edge fundamental and applied research.

Chiba University was founded as a national university in Japan in 1949, when Chiba Normal School, established in 1874, merged with Chiba Medical College and several other educational institutions.

Currently composed of 10 faculties and 13 graduate schools, Chiba University is one of Japan's largest national universities, having about 11,000 undergraduate students, 3,500 graduate students and 3,000 faculty members on 4 campuses located near Tokyo. The main campus at Nishi-Chiba occupies an area of almost 400,000 square meters (100 acres) and is conveniently located between Tokyo Station (about 40 minutes by train) and Narita International Airport. The 850-bed University Hospital, a core hospital for the region, is adjacent to the School of Medicine on the Inohana campus.

Always Aim Higher

CHIBA UNIVERSITY

TABLE OF CONTENTS

REACHING NEW HORIZONS

Welcome to the inaugural issue of *Chiba Research*, a new publication that showcases the diverse and innovative work being undertaken at the Institute for Global Prominent Research (IGPR), Chiba University. The institute was established in 2016, with the ambitious goal of becoming a global hub for top-class research in fields as far-reaching as neutrino astronomy, the science of plant-based medicine, three-dimensional holography, and the creation of a fair, egalitarian society.

The institute is an exciting new initiative at Chiba University. It was set up to nurture key research projects being conducted at the university that are deemed to be of special significance. This issue introduces the fifteen innovative projects currently underway at IGPR. All of these projects were selected by an advisory board that included external experts.

Three of these projects have been singled out as being of top importance — Toshinori Nakayama's work on finding unconventional vaccines that are administered via the mouth, nose or other mucosal system through which most pathogens enter the body (see page 4); Takashige Omatsu's research into spiral-shaped laser beams that exhibit left- and right-handedness and can be used to create helical nanostructures (see page 6); and Shigeru Yoshida's use of ghost-like elementary particles known as neutrinos to explore the high-energy Universe (see page 8).

We trust you will become as enthusiastic as we are about this new initiative, and we look forward to presenting the latest findings from these projects over the coming years.

FORGING AHEAD WITH CREATIVE AND ORIGINAL RESEARCH

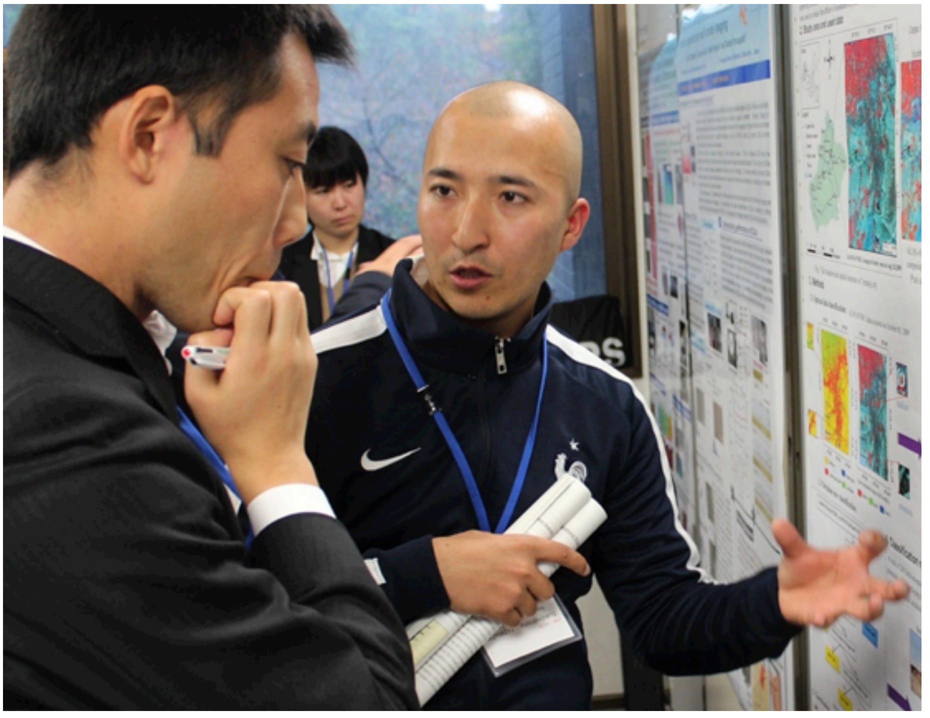
A one-day kickoff symposium provided a glimpse into the innovative research underway at Chiba University

A symposium at Chiba University on 14 November 2016 marked the establishment of the Institute for Global Prominent Research (IGPR). The gathering, attended by approximately 300 participants, introduced 15 innovative research projects that have been selected for the IGPR, and gave members of the different projects the opportunity to interact.

"IGPR's mission is to cultivate groups that perform novel and original research by strategically allocating resources to promote world-level research," explained Ryoji Matsumoto, vice president for research at Chiba University. Of the 15 programs, some strategic priority areas of research will be promoted intensively and others have been designated incubator programs.

The day began with an address by Akihiro Sato from the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), who encouraged participants to pursue world-class research at Chiba University. His talk followed with an overview of IGPR by Chiba University President Takeshi Tokuhisa.

In the keynote lecture, Toshio Hirano, president of the National Institutes for Quantum and Radiological Science and Technology (QST), drew on his previous experience as president of Osaka University and spoke on the importance of instituting reforms at universities.



A poster session at the Institute for Global Prominent Research Kickoff Symposium gave young researchers the chance to showcase their findings and to learn about the work others are doing in different fields.

Two guest lecturers were invited to speak at the launch. Immunologist Kensuke Miyake from the University of Tokyo shared his team's work on the use of nucleic acids to sense molecular mechanisms in the innate immune system. And chemist Marc Koper of Leiden University in the Netherlands elaborated on his theoretical analysis of electrochemical reactions for generating carbon-dioxide-neutral fuels.

The gathering gave the heads of three strategic priority research promotion programs the opportunity to introduce their work. Toshinori Nakayama of the Graduate School of Medicine is exploring unconventional vaccines. These novel vaccines would be administered, not by injection, but via the mouth, nose or other mucosal systems. His team has also discovered the molecular mechanisms underlying the generation and maintenance of immunological memory, which provides the basis for developing vaccines.

Aya Ishihara from the International Center for Hadron Astrophysics (ICEHAP), Graduate School of Science, is using ghost-like elementary particles known as neutrinos to clarify how extremely high-energy cosmic rays are generated. ICEHAP is a key collaborator in IceCube, the international neutrino detector in Antarctica.

Takashige Omatsu of the Graduate School of Advanced Integration Science is employing special laser beams — dubbed optical vortices because of their helical structures — to create nanostructures with unique features. Just as gloves come in pairs — a left and a right hand — so do optical vortices. This property is known as chirality and is very important in many areas of science.

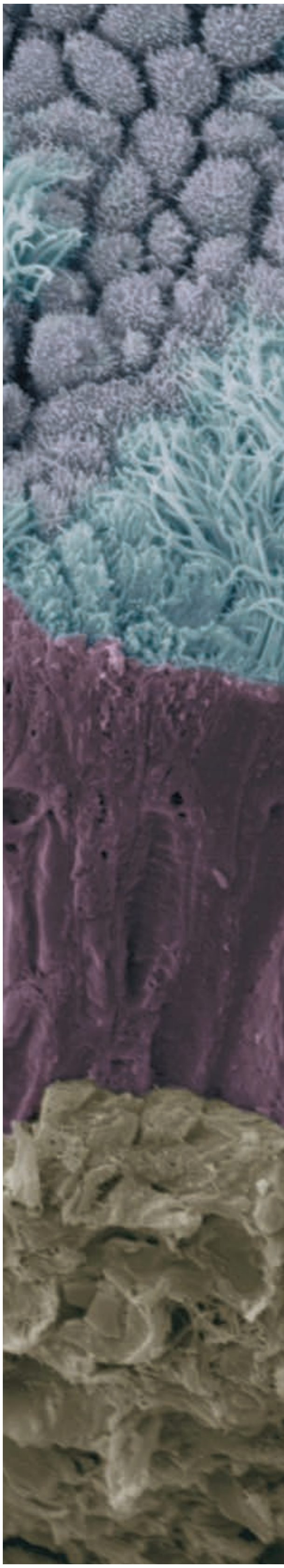
The IGPR symposium also featured three talks on incubator projects: Kazuki Saito on the molecular investigation of bioactive compounds found in plants that have beneficial properties, Hideaki Haneishi on the development of multimodal medical engineering to realize precision medicine; and Josaphat Tetuko Sri Sumantyo on innovative microwave remote sensing for disaster management.

Young and ambitious researchers presented their findings during a one-hour poster session. "The poster session was a valuable chance for young researchers to interact with scientists from other groups," said Matsumoto. "Such interaction can spawn interdisciplinary projects." ■

INTERNATIONAL CENTER OF EXCELLENCE IN MUCOSAL IMMUNOLOGY AND INNOVATIVE ALLERGY THERAPEUTICS

FIGHTING PATHOGENS AT THEIR POINT OF ENTRY

Vaccines that induce immune responses at mucosal membranes of the intestines, lungs and other organs could help prevent deadly infections



© Science Photo Library/Alamy Stock Photo

The mucous membranes that line many of the tracts and structures in the body are the first lines of defense against foreign invaders. Equipped with a powerful and highly specialized immune system, these mucosal sentinels protect the surfaces and, by extension, the body interior, against the threat of gastrointestinal, respiratory and sexually transmitted infections, as well as cancer, allergies and more.

If these immune cells let their guard down, pathogens such as bacteria and viruses can invade. On the other hand, if they are overly vigilant, hyper-reactive conditions like asthma or autoimmune inflammatory bowel disease can take hold.

Getting the balance right is the goal of the International Center of Excellence in Mucosal Immunology and Innovative Allergy Therapeutics.

Launched as a joint initiative between Chiba University and the University of California, San Diego, in 2016, the center aims to harness the power of the mucosal immune system to develop the next generation of preventive vaccines against infectious, allergic and inflammatory diseases.

Most vaccines in use today are administered by injection. But since most infectious agents enter the body at mucosal surfaces, vaccinating through the nose, mouth, or some other mucosal route could provide more protection. Since transmission often occurs at these sites, boosting the body's ability to block that transmission could stop an infection or autoimmune reaction at its source.

"While existing injectable vaccines are able to prevent serious conditions from developing, they are not effective enough to defend against infection," notes program director, Toshinori Nakayama.

FROM BASIC RESEARCH TO CLINICAL APPLICATIONS

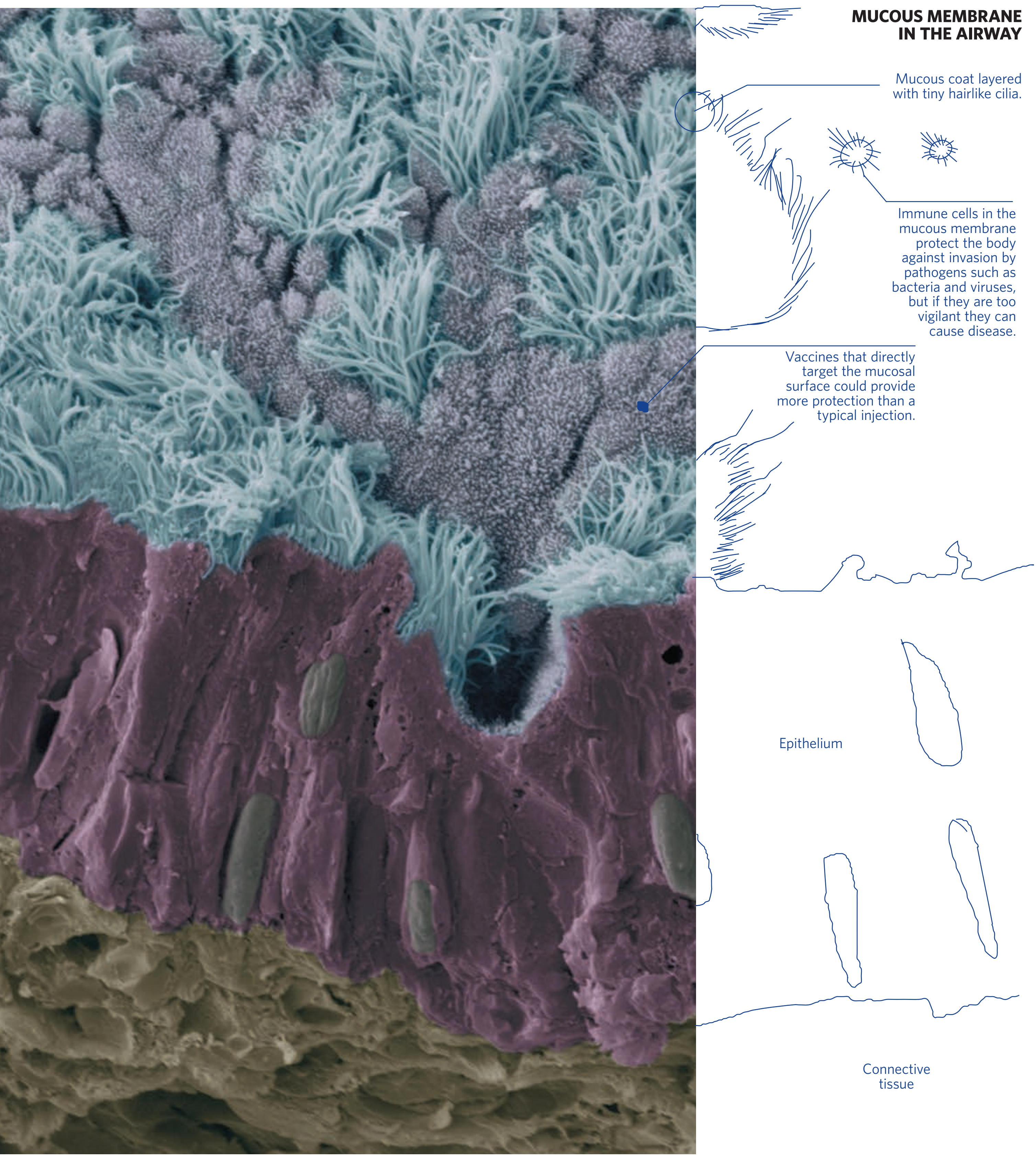
Before new treatments can be developed, however, much more needs to be learned about the molecular architecture of the mucosal immune system. That is why the International Center of Excellence is focusing on basic research while simultaneously advancing clinical applications. It is also strengthening ties between researchers and industry in the hope of translating its discoveries into therapies for patients.

To this end, Nakayama is building a robust pipeline of talented scientists who can move research findings seamlessly from the lab bench to the hospital bedside.

"The research system we are creating is unprecedented," says Nakayama, who is also vice president of Chiba University and dean of the Graduate School of Medicine and the Faculty of Medicine.

Projects at the International Center of Excellence fall into three categories: Hiroshi Kiyono and Satoshi Uematsu are studying the basic mechanisms of mucosal immunology in response to microbial infections and assorted diseases; Nakayama and colleagues, including Mark Bix, Atsushi Onodera, Motoko Kimura and Osamu Ohara, are focusing on allergic reactions and novel treatments that target the mucosa; and Hiroshi Nakajima, Yoshitaka Okamoto and Naoki Shimojo belong to the clinical research team that is developing new vaccines and adjuvants for pathogens endemic to Japan and around the world.

Chiba has initially committed US$2 million over five years to this alliance. Together with a matching contribution from UC San Diego, the project will facilitate joint research and exchanges between investigators and students on both sides of the Pacific. ■

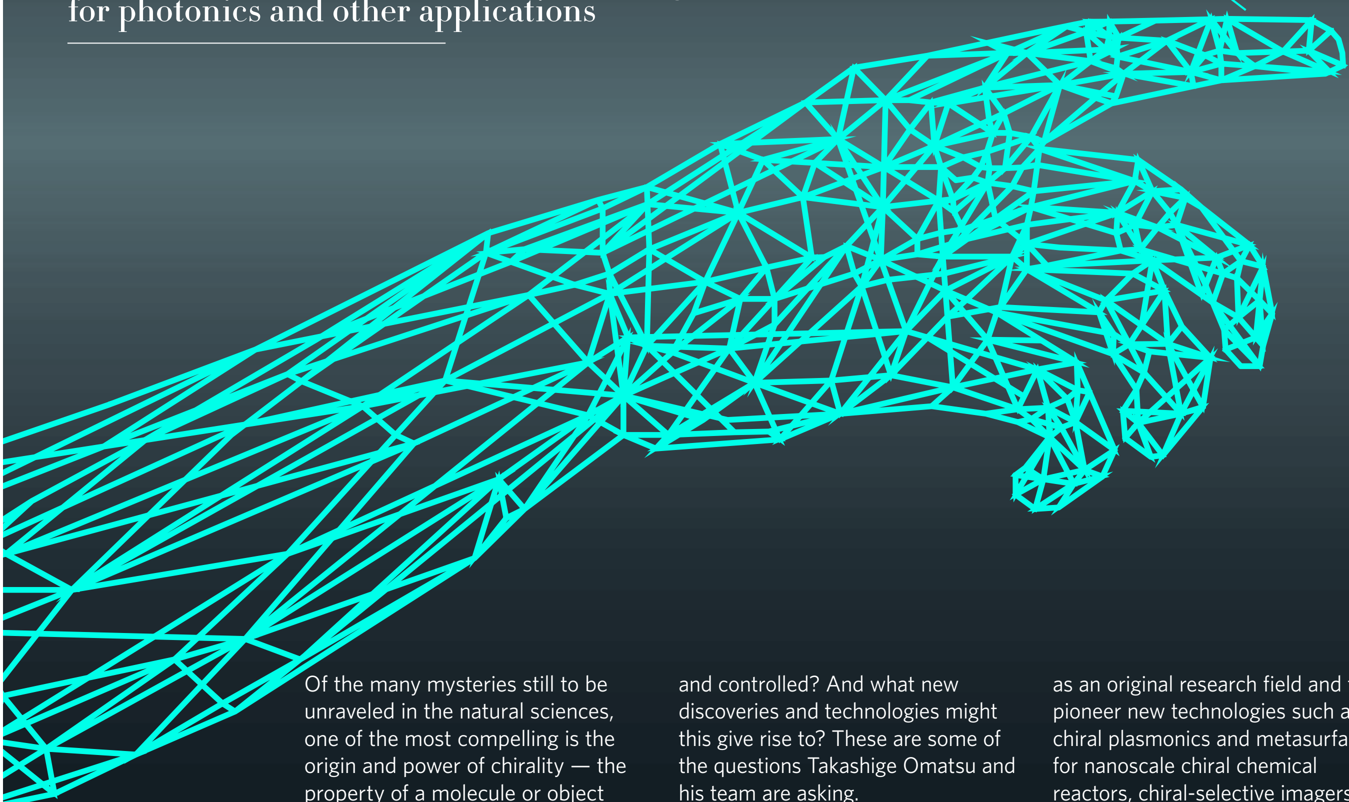

MUCOUS MEMBRANE IN THE AIRWAY
Mucous coat layered with tiny hairlike cilia.
Immune cells in the mucous membrane protect the body against invasion by pathogens such as bacteria and viruses, but if they are too vigilant they can cause disease.
Vaccines that directly target the mucosal surface could provide more protection than a typical injection.
Epithelium
Connective tissue

CHIRAL MATERIALS SCIENCE

USING LIGHT TO ESTABLISH A NEW FIELD OF CHIRAL MATERIALS

Understanding the universal property of chirality could lead to new materials and technologies for photonics and other applications

The property of having two mirror-image forms — like a left and a right hand — is known as chirality and abundant in nature.



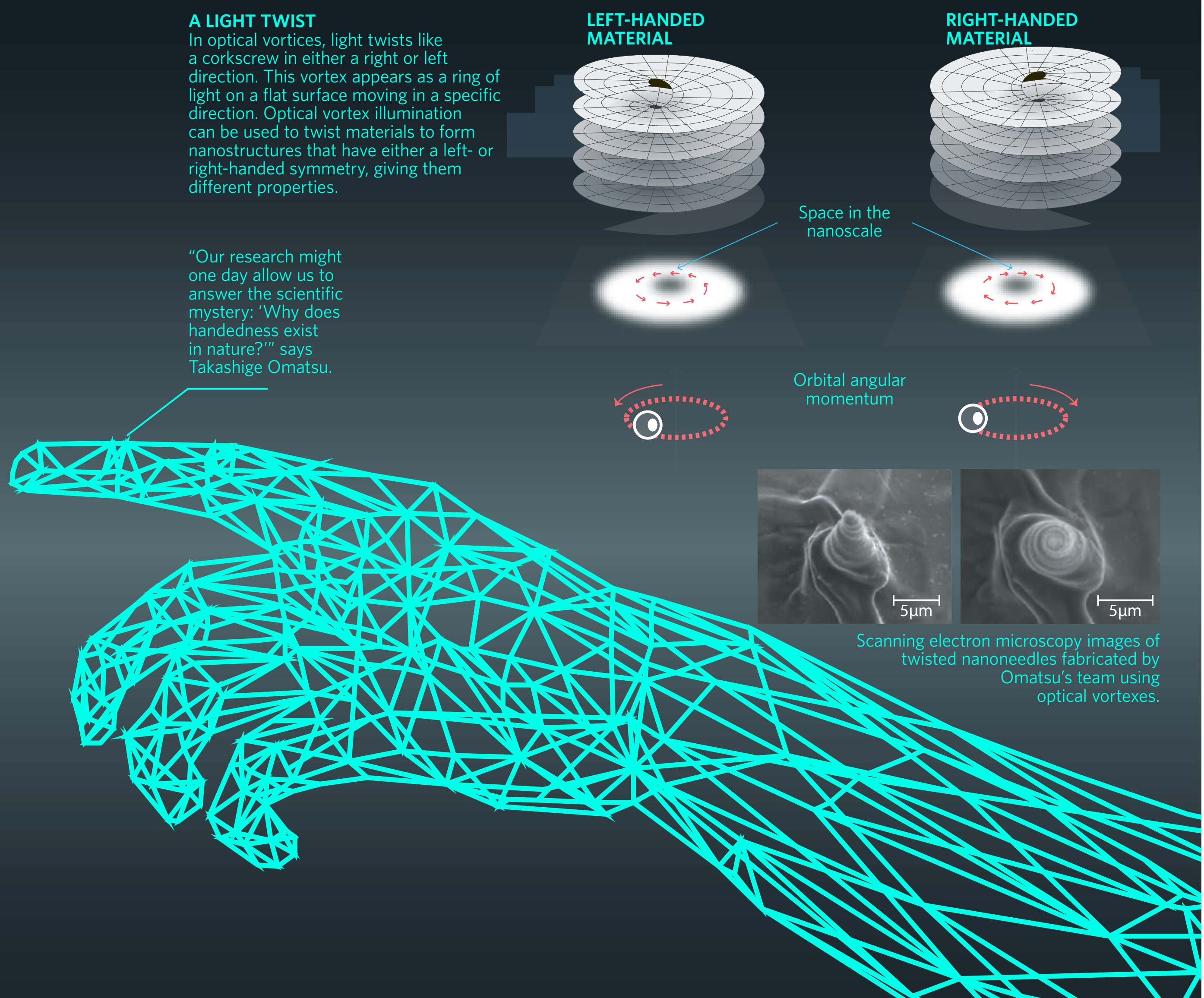
Of the many mysteries still to be unraveled in the natural sciences, one of the most compelling is the origin and power of chirality — the property of a molecule or object that has two mirror-image forms — like our left and right hands.

Chirality is universal in biology, chemistry and physics. It critically affects the biochemical processes underpinning life, is a vital aspect of drug discovery, and crops up in particle physics. Light can have chiral properties that affect how it interacts with matter. But how can the power of chirality be harnessed and controlled? And what new discoveries and technologies might this give rise to? These are some of the questions Takashige Omatsu and his team are asking.

Light beams can be chiral when they are imparted with so-called helical wavefronts, that is, polarity that rotates either left or right. "We can use 'optical vortices' to twist the physical properties of metals, semiconductors and organic materials on the nanoscale to create chiral nanostructures with unique features," says Omatsu. "Our goal is to establish chiral photonic materials as an original research field and to pioneer new technologies such as chiral plasmonics and metasurfaces for nanoscale chiral chemical reactors, chiral-selective imagers and chiral sensors," he explains.

LIGHT CORKSCREWS

Omatsu's team focuses on the interaction between helical light and materials, and the physical properties and potential uses of such modified materials. The electromagnetic field of helical light rotates as the light moves through space. When this field interacts with conductive materials



Scanning electron microscopy images of twisted nanoneedles fabricated by Omatsu's team using optical vortexes.

like metals, nanoscale corkscrew-like variations in physical properties can be inscribed on the material's surface. The modified surface can then react differently to left- and right-handed chiral molecules or helical light, giving rise to a range of interesting possibilities for chemical sensing, synthesis and imaging.

"We can use helical light to create nanostructures such as twisted needles, twisted reliefs and twisted fibers," says Omatsu. "We have also found that the same process can polymerize fullerene — a well-known functional organic molecule that is normally not conductive. This causes fullerene to form a novel conductive metallic phase, which could be used as the basis for fabricating electronic devices without metals and semiconductors."

Omatsu believes 'nanovortices' will one day be used for nanoscale precision control of light polarization, electron orbital motion and the aggregation of chiral molecules. "Our research will lead to materials for next-generation photonics and electronics, and new applications in chemical synthesis, pharmacy, biology and medicine," he says. "It might also allow us one day to answer the scientific mystery: 'Why does handedness exist in nature?'"

Omatsu has collaborated with many Japanese and international researchers, and is always looking for students and early career researchers. "Our research center brings together physicists, chemists, biologists and even medical doctors, and we frequently have brainstorming meetings to think up ideas for new projects," he says. "Several international researchers work here. There is a wonderful diversity of backgrounds and expertise." ■

INTERNATIONAL CENTER FOR HADRON ASTROPHYSICS

REVEALING HIDDEN MESSAGES FROM THE COSMOS

From a remarkable observatory **buried deep in the south polar ice, Chiba University astrophysicists are helping to explore the origins of the Universe**

Amundsen-Scott station in Antarctica.

Humans have been observing the stars for tens of thousands of years, first with our eyes, then with optical telescopes, and more recently using devices that can detect light at the extremes of the electromagnetic spectrum far beyond the visible range. Yet despite phenomenal progress in astronomy over the past half century, much of the Universe remains completely hidden from view, obscured by other matter, other radiation sources, and light's interaction with the interstellar medium.

Now, scientists are on the verge of being able to peer into some of the most mysterious corners of the cosmos using not light but neutrinos — near-massless subatomic particles that travel close to the speed of light across the Universe without being deflected by magnetic fields or absorbed by matter.

The International Center for Hadron Astrophysics (ICEHAP) led by Shigeru Yoshida is part of the global collaboration responsible for constructing the IceCube Neutrino Observatory deep in the ice at the South Pole's Amundsen–Scott station. "One of the longest standing puzzles in astrophysics is the origin of high-energy cosmic rays and neutrinos," says Yoshida. "The new windows to our Universe opened by neutrino observations, combined with powerful computer simulations of cosmic plasma, have great potential to finally resolve this mystery."

THE ICECUBE COLLABORATION

Neutrinos are the most abundant particles in the Universe after photons (light particles). They originate in some of the most violent and least understood cosmological phenomena like supernovas, galactic cores and black holes. After their birth, they travel in straight lines from their source with almost no deflection or absorption, making them ideal messengers from the heart of these mysterious astronomical objects. But these same properties also make them exceedingly difficult to detect.

The IceCube collaboration, involving 300 physicists from 48 institutions in 12 countries, has gone to extreme lengths to detect these ghost-like, high-energy particles. The IceCube observatory is a cubic kilometer of crystal-clear ice, deep below South Pole Station — the only place on Earth where such large volumes of clear, pure and stable ice can be found along with the infrastructure needed to support scientific research.

By suspending thousands of delicate photodetectors on strings in a network of vertical holes drilled through the ice, physicists can capture the rare explosion of energy that occurs when a neutrino collides with an oxygen or hydrogen nucleus. Of the trillion, trillion neutrinos that pass through IceCube every day, the facility records just a few hundred collisions from high-energy neutrinos — a minute fraction of the neutrino flux but more than enough to stimulate some very exciting research.

Another important contribution of ICEHAP to understanding the high-energy Universe is its supercomputer-based massive numerical simulation program for deep investigation of the physical mechanisms behind high neutrino production. "We are proud of having been key players in the discovery of high-energy cosmic neutrinos, which astrophysicists have been dreaming about for more than 30 years," says Yoshida. "This is a big step forward in astrophysics. Through our simulations we are helping to uncover the hidden messages carried by these neutrinos and to reveal the physical mechanism by which high-energy cosmic rays are accelerated at their source." ■

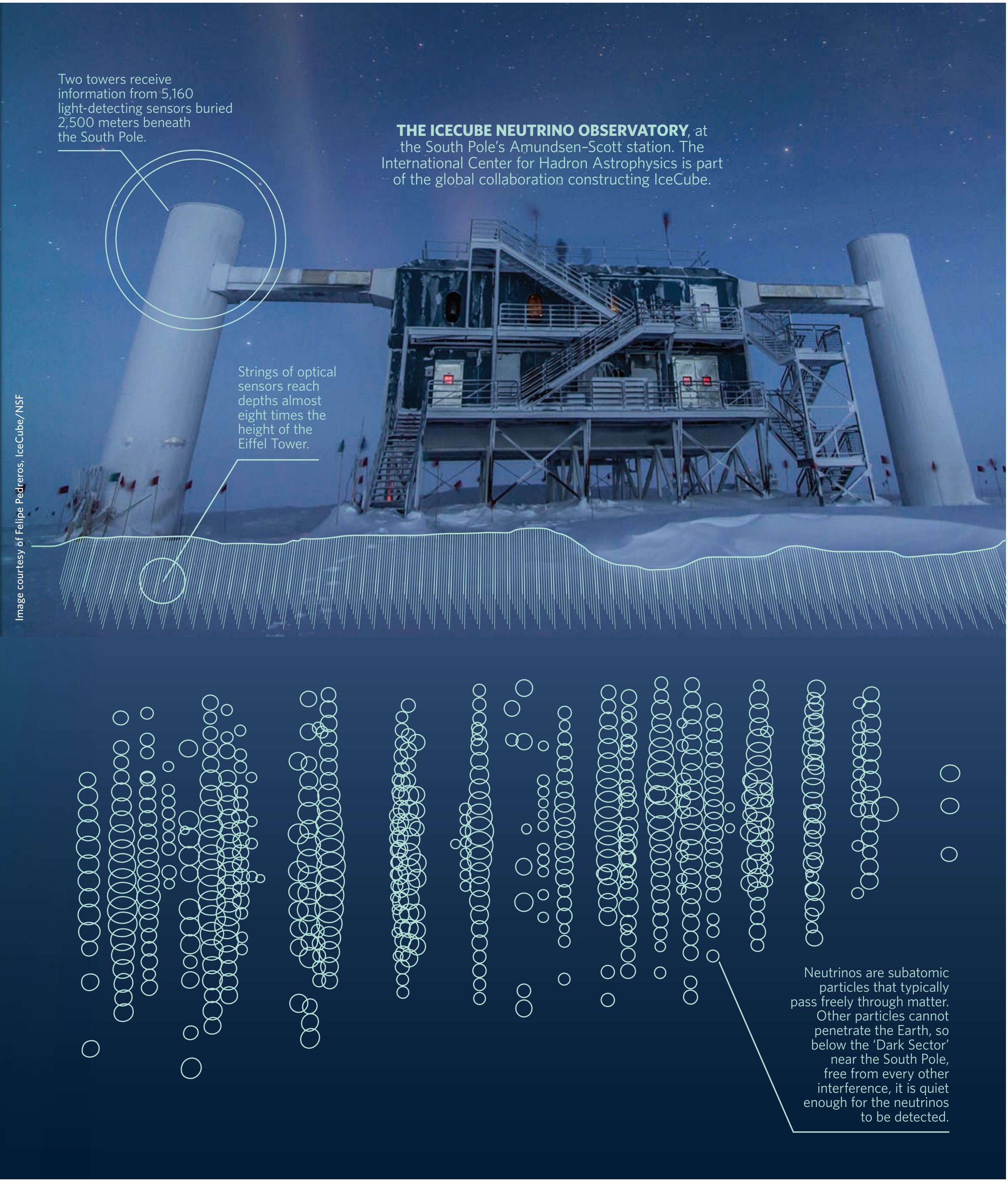


Image courtesy of Felipe Pedreros, IceCube/NSF

PHYTOCHEMICAL PLANT MOLECULAR SCIENCES

UNLOCKING THE POTENTIAL OF PHYTOCHEMICALS

Advanced genetic and genomic techniques **are transforming our understanding of how phytochemicals can improve human health**

Since ancient times, people have used the natural compounds in plants, known as phytochemicals, for medicinal and nutritional use. Now, scientists at Chiba University are using advanced genetic and genomic techniques to verify how phytochemicals are generated in plants, how they can be manipulated to optimize certain plant groups, and how they may help tackle lifestyle- and aging-related diseases.

Plants naturally generate chemicals for various purposes, including for attracting pollinators and defending themselves. These specialized metabolites allow plants to colonize specific niches in the food chain, adapt to new environments and evolve to survive potential stressors. Crucially, phytochemicals also exhibit properties that can help treat human diseases. Examples in modern medicine include morphine, the antimalarial drug artemisinin and chemotherapy agents derived from taxanes.

ENLISTING PHYTOCHEMICALS TO FIGHT DISEASE

Kazuki Saito, who leads the Phytochemical Plant Molecular Sciences program, says that because phytochemicals display considerable natural diversity, they have huge potential to fight disease. "Although phytochemicals have been used in pharmaceuticals and ancient remedies for many years, it is only now, with the advent of next-generation DNA sequencing, that we can really begin to understand how they work and unlock their full potential," says Saito.

The program consists of three collaborative research groups, each working on a specific theme.

One group is focusing on the genomics of medicinal plants and food crops with the key aim of revealing the genomic principles of phytochemical production. Employing state-of-the-art technologies, the researchers identify and clarify the roles of unknown genes, as well as investigate plant metabolism.

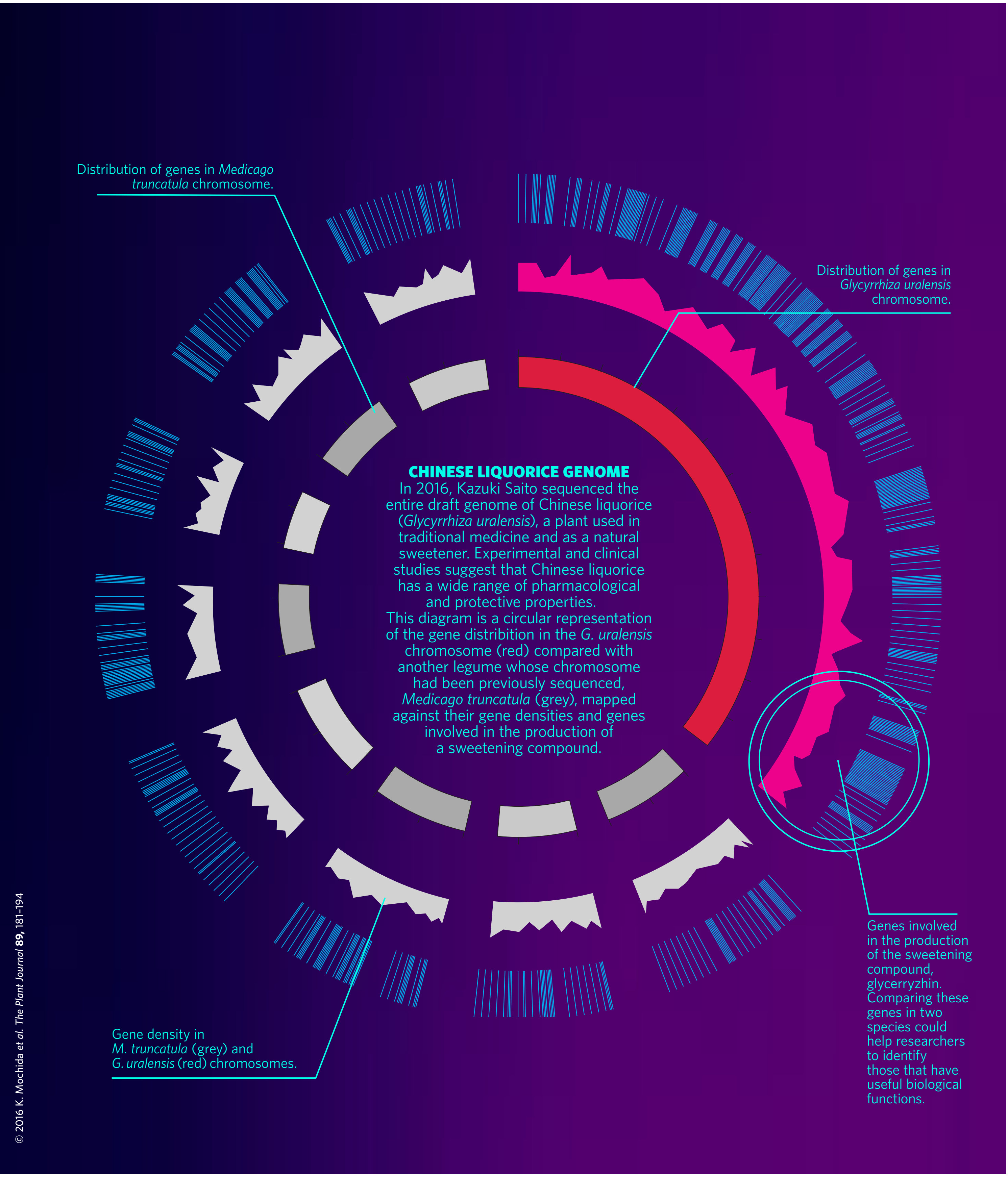
In 2016, Saito's team assembled a draft genome for licorice (*Glycyrrhiza uralensis*), which is used worldwide as a natural sweetener and a medicinal component. They identified several components known to play a positive role in human health within the plant, while pinpointing key genes, the manipulation of which could lead to crop improvements.

The second team is identifying novel phytochemicals and active products in a wide variety of plants, searching for drug components to tackle diseases such as cancer, dementia and diabetes. As well as isolating and analyzing promising molecules, the group conducts animal trials to assess the pharmaceutical potential of molecules. In particular, they have extensively investigated Lycopodium alkaloids (LAs), molecules found in the vascular plant Lycopodiaceae, which may help to treat Alzheimer's disease and schizophrenia.

The third group is investigating how plants respond to different environmental stresses by growing plants in different artificial environments and monitoring their responses to change.

"Our aim is to optimize plants so that they produce high-quality phytochemicals that we can harvest for use in medicines and functional foods," explains Saito. "Our insights will enable us to grow rare plants more successfully and will also inform agricultural practices for commercial crops in the future."

While the group is focusing on phytochemicals, it also conducts wide-ranging interdisciplinary studies and hence welcomes researchers and students with backgrounds in chemistry, horticulture, genetics and pharmacy who are interested in this exciting and rapidly developing area of research. ■


Distribution of genes in *Medicago truncatula* chromosome.
Distribution of genes in *Glycyrrhiza uralensis* chromosome.
CHINESE LIQUORICE GENOME
In 2016, Kazuki Saito sequenced the entire draft genome of Chinese liquorice (*Glycyrrhiza uralensis*), a plant used in traditional medicine and as a natural sweetener. Experimental and clinical studies suggest that Chinese liquorice has a wide range of pharmacological and protective properties.
This diagram is a circular representation of the gene distribition in the *G. uralensis* chromosome (red) compared with another legume whose chromosome had been previously sequenced, *Medicago truncatula* (grey), mapped against their gene densities and genes involved in the production of a sweetening compound.
Gene density in *M. truncatula* (grey) and *G. uralensis* (red) chromosomes.
Genes involved in the production of the sweetening compound, glycerryzhin. Comparing these genes in two species could help researchers to identify those that have useful biological functions.

CENTER FOR INNOVATIVE MICROWAVE REMOTE SENSING

THE NEXT WAVE IN REMOTE SENSING

***Microsatellites and remote imaging technology* are revolutionizing the way we predict earthquakes and monitor disaster zones**

The Josaphat Microwave Remote Sensing Laboratory (JMRSL) is far more than a laboratory. It is an experimental aerospace workshop where world experts in remote sensing collaborate with mechanical and aerospace engineers to construct state-of-the-art microsatellites and airborne sensors. The JMRSL specializes in microwave-radar technology for detecting ground movements and earthquake predictors as part of a new generation of remote sensing technologies.

"Microwave radiation is particularly useful for remote sensing because it penetrates cloud, haze and fog, allowing us to observe the Earth's surface from space," explains Josaphat Tetuko Sri Sumantyo, the laboratory's namesake.

The core area of research at the JMRSL is the development of synthetic aperture radars (SARs) for microwave remote sensing to monitor land deformation. SAR emits a microwave signal in the direction of the target and then detects microwaves scattered from the target. By comparing SAR images obtained before and after a change such as an earthquake or a landslide, researchers can determine how much the land has moved.

The JMRSL has a well-developed research-and-development program with 15 researchers, 25 students and facilities for designing, manufacturing, calibrating and operating SAR for both aircraft and microsatellite applications.

ADVANCED AEROSPACE FACILITIES

"Our facilities include an anechoic chamber for calibrating sensors, a satellite–ground communication system, and microsatellite calibration and measurement systems. We also have a simulator for designing microwave circuits and antennas, along with a suite of manufacturing equipment," says Sri Sumantyo. "We even have our own 6-meter experimental unmanned aerial vehicle, the JX-1, which we developed in this laboratory."

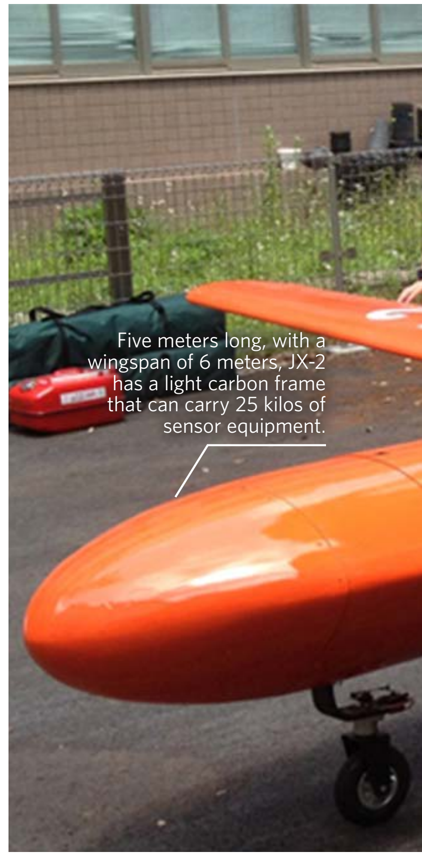
The JMRSL has already developed SAR sensors for circularly polarized (CP) microwave radiation in the L, C and X bands, which have been deployed on both large and small aircraft, as well as on the JX-1. The CP-SAR sensor is the first of its kind, utilizing interference between left- and right-handed circularly polarized light to obtain precise information about the Earth's surface in a compact, lightweight and inexpensive sensor.

"With funding from the governments of Japan, Malaysia, Indonesia and Korea, we have developed several techniques based on SAR imaging to monitor infrastructure and areas affected by disasters such as forest fires, landslides, subsidence and volcanic eruptions," says Sri Sumantyo.

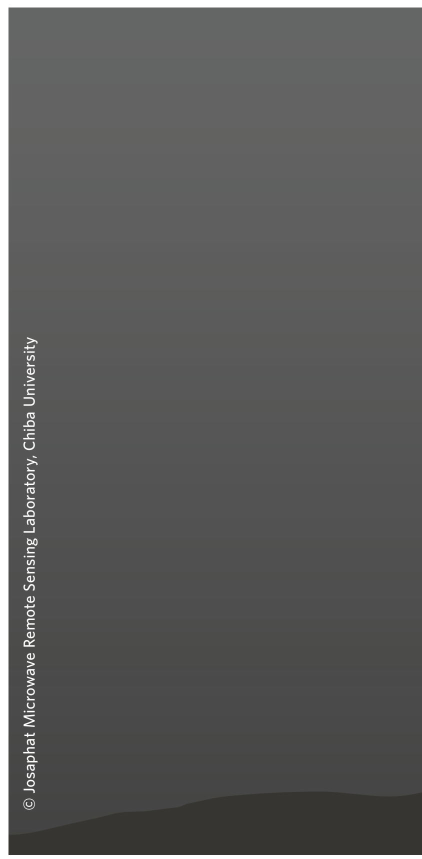
Engineers at the JMRSL are developing two novel microsatellites. One is equipped with radio occultation and electron density temperature probe sensors for measuring the atmospheric signatures thought to precede earthquakes, while the other is a CP-SAR satellite with lightweight gold-coated mesh antenna. These satellites are poised to take the lab's research beyond the stratosphere.

"Our microsatellite program is very exciting for future SAR sensor applications and planetary exploration," says Sri Sumantyo. "We eventually aim to have five microsatellites in orbit, which will provide real-time monitoring for global disaster mitigation and research. Right now, we are preparing to build our first engineering model, with the flight model to come soon."

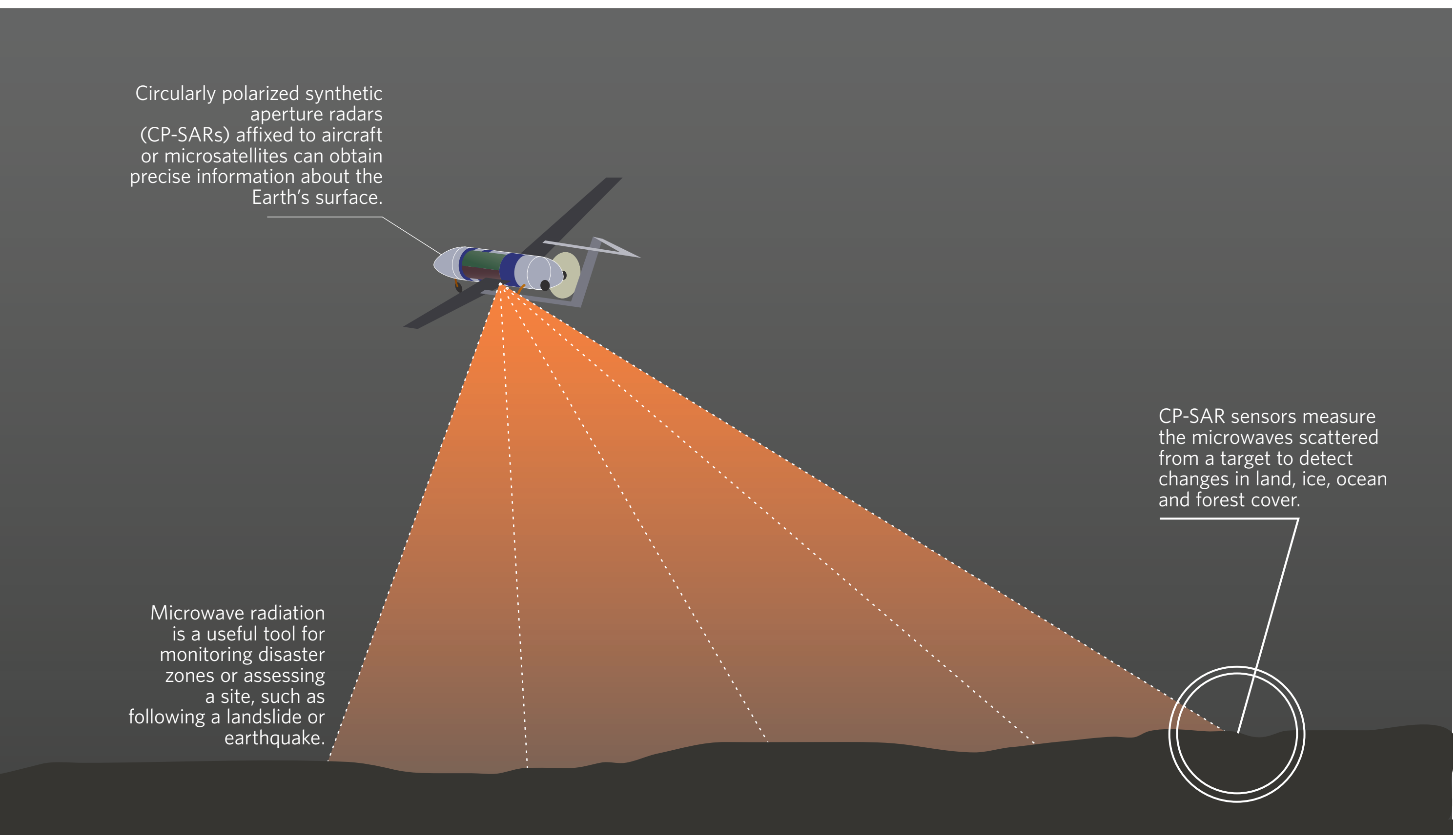
The JMRSL has strong collaborations with Japanese and overseas research institutions and industry — it has more than 50 agreements with research and industry partners throughout the world. The group also encourages short- and long-stay programs under various government programs, through which more than 500 students and researchers from many different countries have worked at the lab. ■



Five meters long, with a wingspan of 6 meters, JX-2 has a light carbon frame that can carry 25 kilos of sensor equipment.



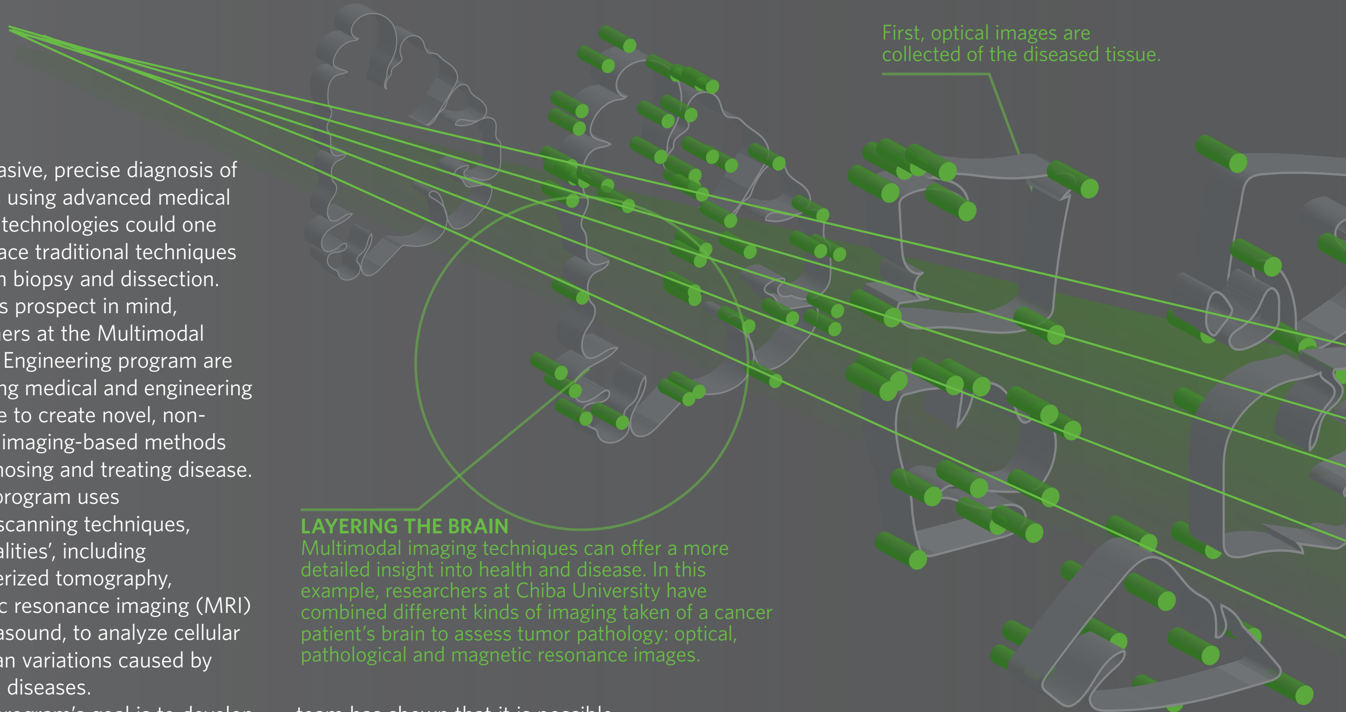
IN PLANE VIEW
Josaphat Tetuko Sri Sumantyo's team at Chiba University built the unmanned aerial vehicle JX-2, which is equipped with microwave sensors that can penetrate clouds to scan the Earth.



MULTIMODAL MEDICAL ENGINEERING

TOWARD IMAGE-BASED DISEASE DIAGNOSTICS

Novel, high-precision imaging techniques are being used to provide non-invasive disease diagnosis and guide future treatments



LAYERING THE BRAIN
Multimodal imaging techniques can offer a more detailed insight into health and disease. In this example, researchers at Chiba University have combined different kinds of imaging taken of a cancer patient's brain to assess tumor pathology: optical, pathological and magnetic resonance images.

Non-invasive, precise diagnosis of diseases using advanced medical imaging technologies could one day replace traditional techniques based on biopsy and dissection. With this prospect in mind, researchers at the Multimodal Medical Engineering program are combining medical and engineering expertise to create novel, non-invasive imaging-based methods for diagnosing and treating disease.

The program uses various scanning techniques, or 'modalities', including computerized tomography, magnetic resonance imaging (MRI) and ultrasound, to analyze cellular and organ variations caused by different diseases.

The program's goal is to develop highly precise, non-invasive imaging methods, while boosting existing imaging techniques to improve resolution and enable more-detailed tissue analysis, says program leader Hideaki Haneishi.

"Many current disease diagnostics, particularly for cancer, involve highly invasive, unpleasant procedures to clarify the type and stage of the disease," explains Haneishi. "We are investigating, for example, the development of a system to diagnose breast cancer using very-high-frequency ultrasound."

Rather than physically sampling and dissecting lymph nodes from potentially cancerous tissue, his team has shown that it is possible to analyse cell characteristics of lymph nodes using ultrasound. Their technique highlights metastasis positive and negative cells in lymph nodes, enabling rapid, painless diagnosis.

Haneishi and his team are also devising ways to combine data from two or more modalities. For example, in 2016 they developed an image registration method that transforms two data sets into one coordinated system using MRI and pathological images of brain tumors.

"If we can establish the technology for registering two kinds of images, then MRI features that are strongly related to the pathological features of tumors can be highlighted. This may eventually allow us to diagnose using only MRI," says Haneishi. "Determining the relationships between different data sets helps us build up detailed pictures of what is going on inside the body, not only for diagnosis but also to improve our understanding of disease development," he adds

NOVEL OPTICAL PROBES

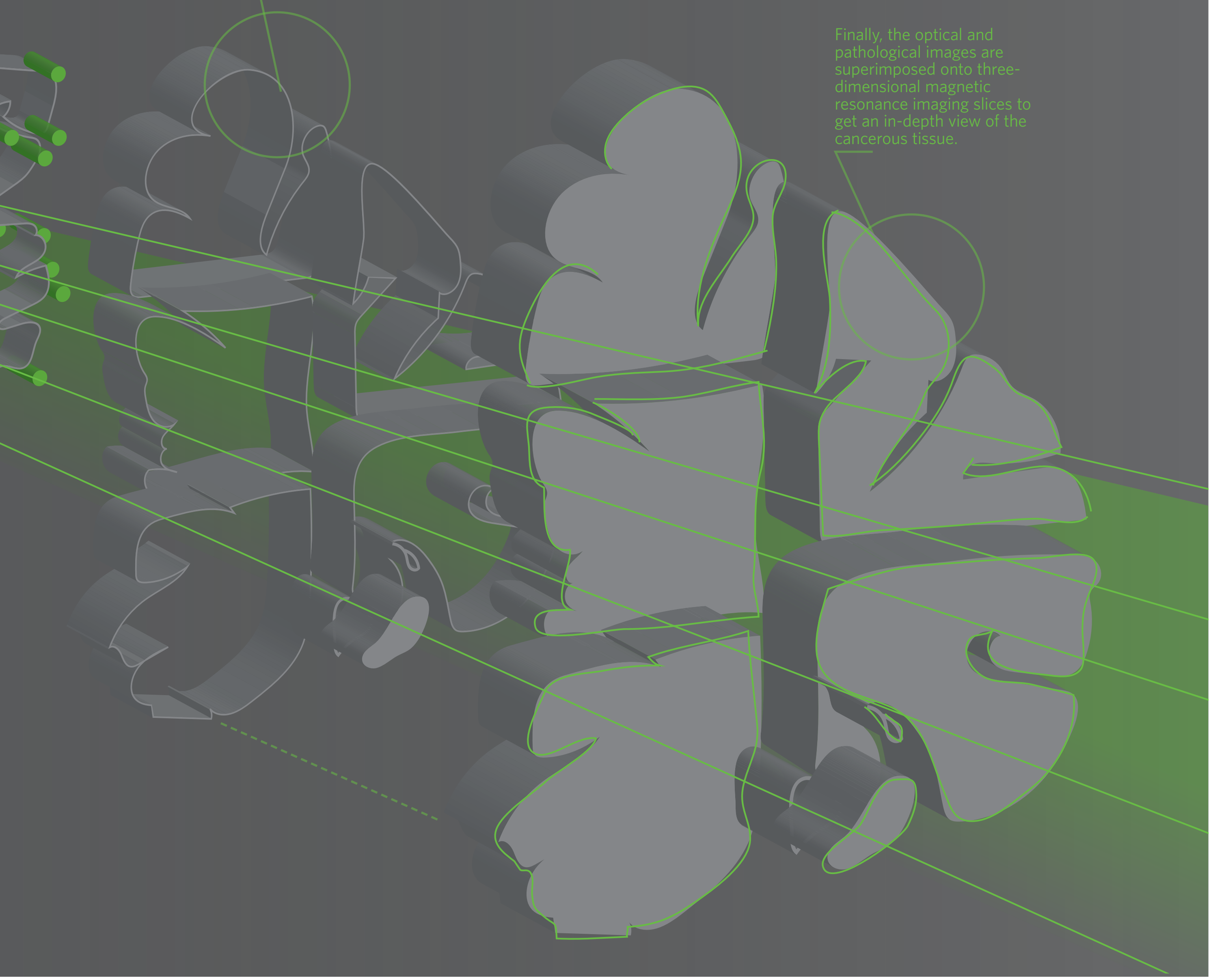
Alongside conventional imaging techniques, the researchers are also exploring novel optical probes. One example involves a method for monitoring microcirculation — the flow of red blood cells — in the body. The probe comprises multicolored light-emitting diodes

(LEDs). As the LED light is scattered through the tissue, it is partly absorbed by molecules in the red blood cells, generating a clear, detailed picture of the cells and their microcirculatory network.

Building on previous work, the team hopes to use this probe to estimate features such as the oxygen saturation of each blood vessel in areas around suspected tumors in real time. This could aid diagnosis and further our understanding of vascular behavior in and around tumors. “Ultimately, we would like to build on these imaging techniques and use machine learning and artificial intelligence technologies to relate measured signals and diagnoses, to develop a comprehensive understanding of different diseases,” says Haneishi.

The Multimodal Medical Engineering program has access to highly specialized equipment and technologies that can help realize researchers’ ideas.

“We welcome engineers and medical researchers who wish to work at the cutting-edge of research and development with direct clinical applications,” says Haneishi. ■



Pathological images are then sliced, digitized and reconstructed like a jigsaw puzzle.

Finally, the optical and pathological images are superimposed onto three-dimensional magnetic resonance imaging slices to get an in-depth view of the cancerous tissue.

CHIBA STUDIES ON GLOBAL FAIR SOCIETY

FORGING A FAIRER WORLD

A multidisciplinary team of researchers looks at how to create a fair society — on a global scale

With globalization comes the need to ensure that people from all cultures, countries and backgrounds are treated fairly and equally. The drive to create a just global society requires solid foundations in all countries, backed by informed government policies and strong support networks at local, regional and national levels.

Much previous research into justice and social change has been dominated by studies of Western societies, but the rapid changes experienced by Asian countries in recent decades have spawned a growing field of research focused on building fair societies in Asia.

Researchers in law, politics, economics and social sciences have recently established the Chiba Studies on Global Fair Society project, with the aim of creating an interdisciplinary research base to inform future local, national and international policies.

Lead researcher on the project, Jiro Mizushima, says the key concept is fairness. "We define fairness as the basic element of justice," he explains. "In fact, we argue that it exceeds justice in most cases. At the same time, we embrace values such as equality and liberty."

Mizushima, whose research interests lie in welfare state reform in Europe, says the project aims to go beyond the traditional discussion of equality — it seeks to construct new principles that value diversity among people in a global society.

HOW DO WE ACHIEVE A FAIR SOCIETY?

The project consists of four interrelated research groups and a further six teams working to publicize the findings to a wide audience. Their focus is on challenging and overcoming unfair practices on all scales, investigating issues such as gender inequality, widening income gaps, migration, and the collapse of regional and marginal communities, both in Japan and around the world.

The key aims of the project are to investigate the development, transformation and limitations of existing welfare state models and to provide empirical evidence for how a fair society can be achieved in the 21st century. Mizushima has spent considerable time researching aspects of the welfare state in the Netherlands, including how it has responded to social challenges such as global economic fluctuations and an aging population.

"Fairness has been the core of legal and political philosophy since ancient times, and so another of our teams is examining equality and fairness from a historical perspective, comparing political, economic and legal standpoints over time," he says. "Another group will analyze the meaning of fairness in the 21st century, providing us with fundamental guidelines to underpin our program."

The team plans to form networks of academics across the globe. To this end, they have hosted two highly successful international symposiums and another one is planned for later this year. "Many of our members are involved in local and national policy-making committees, and they are key to informing policy makers of our work," says Mizushima.

The project welcomes those interested in all aspects of social science, from law and politics to sociology and economics. Students and researchers alike will receive training from scholars in their own field and other program members, allowing them to broaden their research interests. ■

The Chiba Studies on Global Fair Society project goes beyond traditional discussions of equality to construct new principles that value diversity among people in a global society.

ONE WORLD, MANY VOICES

Despite widespread differences in language, customs and cultures, the world is becoming increasingly interconnected. Creating a society where people of all cultures, countries and backgrounds are treated with fairness and equality requires a global effort.

“We define fairness as the basic element of justice,” says Jiro Mizushima. “We embrace values such as equality and liberty.”

Solar cell technologies today are not efficient enough to produce energy on a large scale.

HIGH-EFFICIENCY ENERGY CONVERSION

TOWARD A ZERO-EMISSION SOCIETY

The future of clean energy production **lies in perfecting the nanoscale details of fuel cell components to create an innovative carbon-neutral energy system**

The race is on to find ways to replace our reliance on fossil fuels with clean, sustainable methods of generating power. Current solar and hydrogen technologies are not yet efficient enough to produce energy on a large scale. With this in mind, researchers from the High-Efficiency Energy Conversion program aim to improve current solar and hydrogen fuel cells, while finding ways to reduce the pollutants already in the environment.

"We hope to develop efficient energy conversion systems that don't emit carbon dioxide and pollutants," says Nagahiro Hoshi, lead researcher on the program. "We will create a system that generates power fueled by sunlight and water. To do this, we must perfect the structures of the nanomaterials used to make solar and hydrogen fuel cells to optimize their ability to harness energy."

Hoshi's team works with various nanostructures, including nanoparticles, single-crystal surfaces and organic nanoassemblies, to build devices that can capture as much energy as possible without wastage.

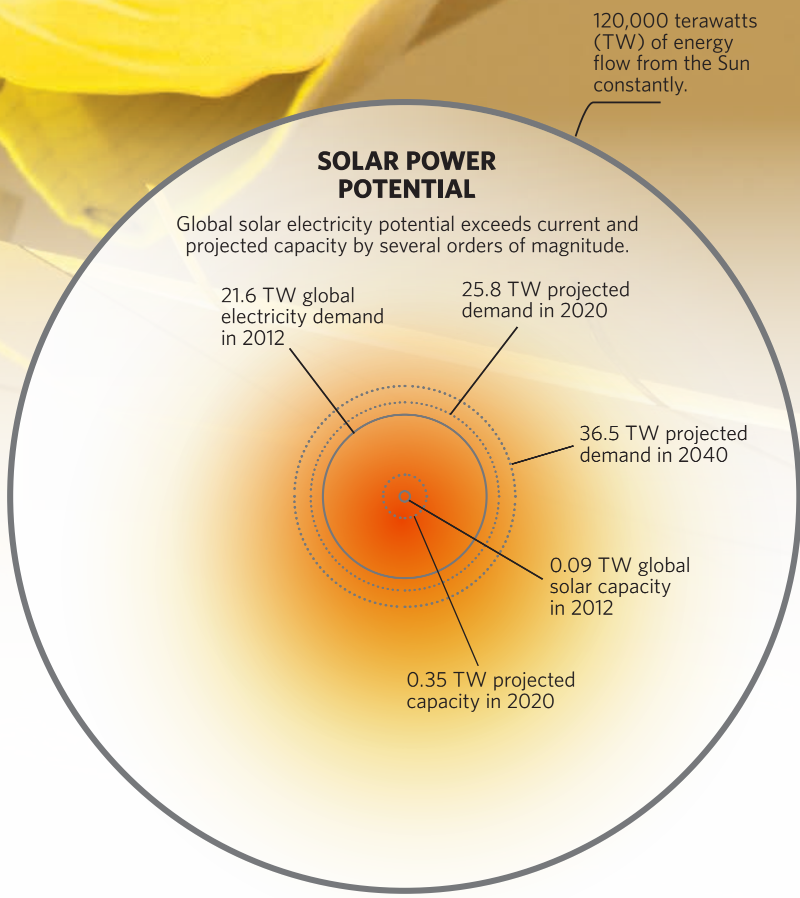
ENHANCING ENERGY CONVERSION

The surface structures of catalysts used in solar cells and hydrogen fuel cells can have a remarkable impact on conversion efficiency. For example, the orientation of atoms on a solar cell's surface significantly affects the distribution of light across the cell.

One way of enhancing a solar cell is to coat its surface with a dye. The dye's atomic make-up contributes to the cell's ability to generate electric current when exposed to light, providing it is adsorbed onto an appropriate surface. The researchers recently explored the effects of using a zinc porphyrin (ZnP) dye on single-crystal titanium dioxide (TiO_2) substrate surfaces. They trialed three different TiO_2 substrates and found that their surface structures significantly altered the ability of the ZnP dye to generate an electric current efficiently. In fact, one of the ZnP TiO_2 substrates had an incident photon-to-current conversion efficiency 13 times higher than one of the others.

Hoshi attributes the high conversion efficiency on this substrate to the bent configuration of the adsorbed porphyrin ring, which results in a shorter distance between the ring and surface. Such attention to detail in terms of nanoscale surface structures will generate the breakthroughs needed to create highly efficient, scalable and cost-effective solar power.

At present, hydrogen is mainly manufactured by using heat and pressure to separate it from natural gases. But since



this manufacturing process also creates large amounts of carbon dioxide, scientists are exploring ways to generate hydrogen from water instead. When burned, hydrogen releases only water and steam, and it has the potential to fuel all kinds of systems. Hoshi's team has developed a hydrogen-based method that could transform excess carbon dioxide into usable fuel.

"We are researching photocatalysts capable of decomposing pollutants such as carbon oxides, ammonia and waste oil," says Hoshi. "We have had recent success in investigating the photocatalytic conversion of carbon dioxide into methane — the reaction pressure needed to reduce the carbon dioxide was created using hydrogen gas."

To help realize this vision of a zero-emission society, Hoshi and his team welcome collaborations with researchers and private companies interested in this burgeoning field of nanotechnology. ■

CANCER EPIGENOME CENTER

A DIFFERENT APPROACH TO FIGHTING CANCER

***A new center aims to combat cancer* by rewriting the epigenetic modifications harbored by tumor cells**

Cancer is thought of as a genetic disease, with mutations to a cell's DNA causing a normal cell to give birth to a malignant tumor. Yet epigenetic alterations, which leave the DNA sequence intact, can be just as important in a cell's transformation to cancer. Even though epigenetic regulation through mechanisms such as methyl tags and histone modifications does not alter the DNA sequence, it can chemically modify the genome to signal which genes should be turned on and off. When tumor-suppressor genes are silenced or oncogenes are activated in this way, many different forms of cancer can result.

Fortunately for medicine, epigenetic alterations are not permanent. They can be undone to prevent or reverse cancer, leaving a cell with its entire complement of normal DNA intact.

This is exactly what researchers at the Cancer Epigenome Center are striving to do. Led by Atsushi Kaneda, the center is seeking to understand the various epigenetic drivers that contribute to different types of cancer and then develop new drugs that overturn these effects.

"We will explain key epigenomic aberrations and their molecular causes," says Kaneda. "And then, taking advantage of small molecules that bind to DNA in a sequence-specific manner, we will develop drugs that can rewrite the accumulated epigenomic aberrations or prevent them accumulating in targeted genomic regions."

UNRAVELING MOLECULAR MECHANISMS

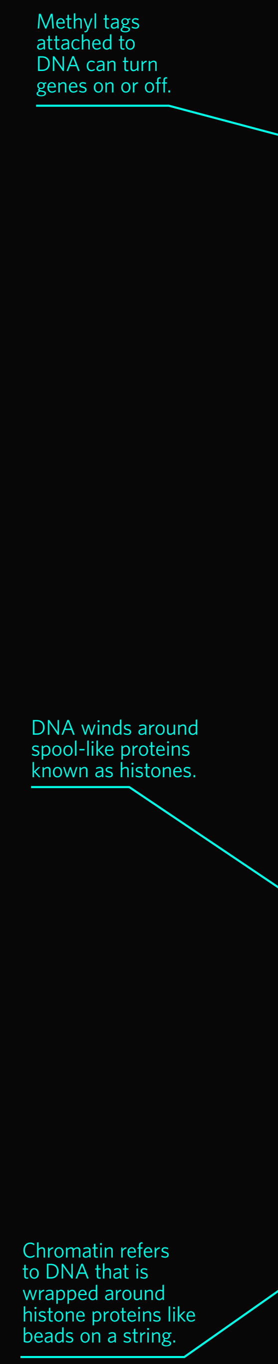
Kaneda points to ongoing investigations of gastric cancer as an example of this strategy in action. Patients with this cancer exhibit different levels of DNA methylation in their tumor cells, depending on the pathogen responsible for the disease. The cancer-causing bacterium *Helicobacter pylori* is one source of irregular methylation, infection with Epstein Barr virus is another. Both seem to have profound epigenetic impacts on stomach cells, leading to the silencing of many tumor suppressors.

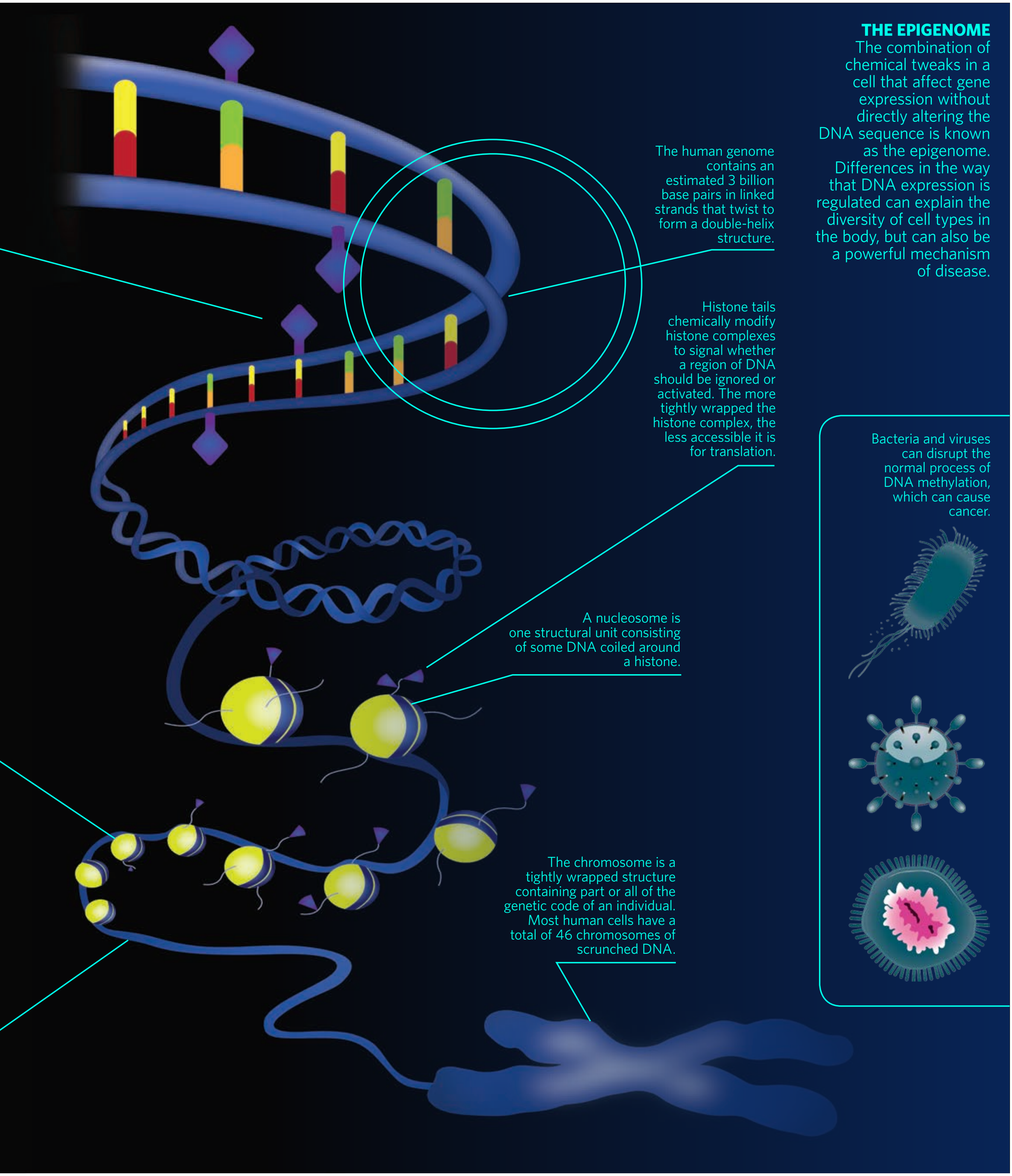
Kaneda and his colleagues are using clinical samples and cell experiments to unravel the molecular mechanisms that induce hyperactive methylation patterns following infection with these pathogenic agents. They ultimately hope to stop the process in its tracks.

Similar projects are ongoing to combat colorectal cancers — which Chiba researchers have shown can be categorized into three types, depending on methylation levels — as well as blood cancers and other types of tumor.

With an eye to developing novel therapeutics, chemists at the Cancer Epigenome Center are working on new methods to efficiently synthesize molecules that can act on epigenetic aberrations. One such group of molecules is the pyrrole-imidazole polyamides. These molecules can bind to DNA at specific sites in the genome, and when coupled to an epigenetic inhibitor they can prevent methylation-based gene silencing. Kaneda hopes to deploy the molecules to edit the epigenome at targeted regions to regulate tumor formation.

The Cancer Epigenome Center includes researchers from a wide range of backgrounds and specialties. This multidisciplinary team approach, says Kaneda, is essential for turning the center's discoveries into clinically meaningful treatments and diagnostic tools. "We will help determine the mechanisms of cancers and develop new cancer drugs through collaborating with experts in medicine, physics and pharmacy," he says. ■

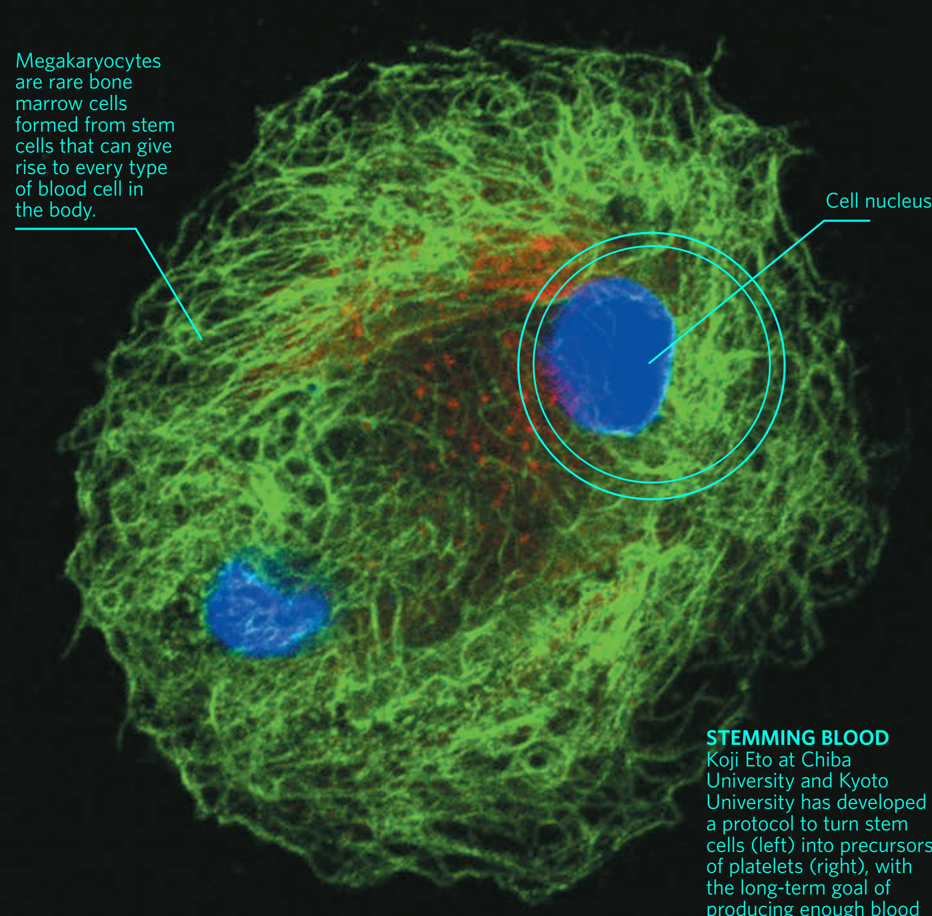



THE EPIGENOME
The combination of chemical tweaks in a cell that affect gene expression without directly altering the DNA sequence is known as the epigenome. Differences in the way that DNA expression is regulated can explain the diversity of cell types in the body, but can also be a powerful mechanism of disease.
The human genome contains an estimated 3 billion base pairs in linked strands that twist to form a double-helix structure.
Histone tails chemically modify histone complexes to signal whether a region of DNA should be ignored or activated. The more tightly wrapped the histone complex, the less accessible it is for translation.
Bacteria and viruses can disrupt the normal process of DNA methylation, which can cause cancer.
A nucleosome is one structural unit consisting of some DNA coiled around a histone.
The chromosome is a tightly wrapped structure containing part or all of the genetic code of an individual. Most human cells have a total of 46 chromosomes of scrunched DNA.

INTEGRATED RESEARCH CENTER ON REGENERATIVE SYSTEMS AND DISEASES

STEEPED IN STEM CELLS

New cell therapies, drugs and disease insights should flow from a coordinated approach to stem cell research



STEMMING BLOOD Koji Eto at Chiba University and Kyoto University has developed a protocol to turn stem cells (left) into precursors of platelets (right), with the long-term goal of producing enough blood for patients in need of transfusions.

Stem cells have the remarkable capacity to both self-renew and give rise to many types of more specialized cells in the body, which explains their great therapeutic potential in regenerative medicine. But that is not the only reason stem cells have become such a hotbed of scientific inquiry — these cellular transformers are also an invaluable research tool for probing the disease mechanisms that underpin cancer, aging and a host of other health problems.

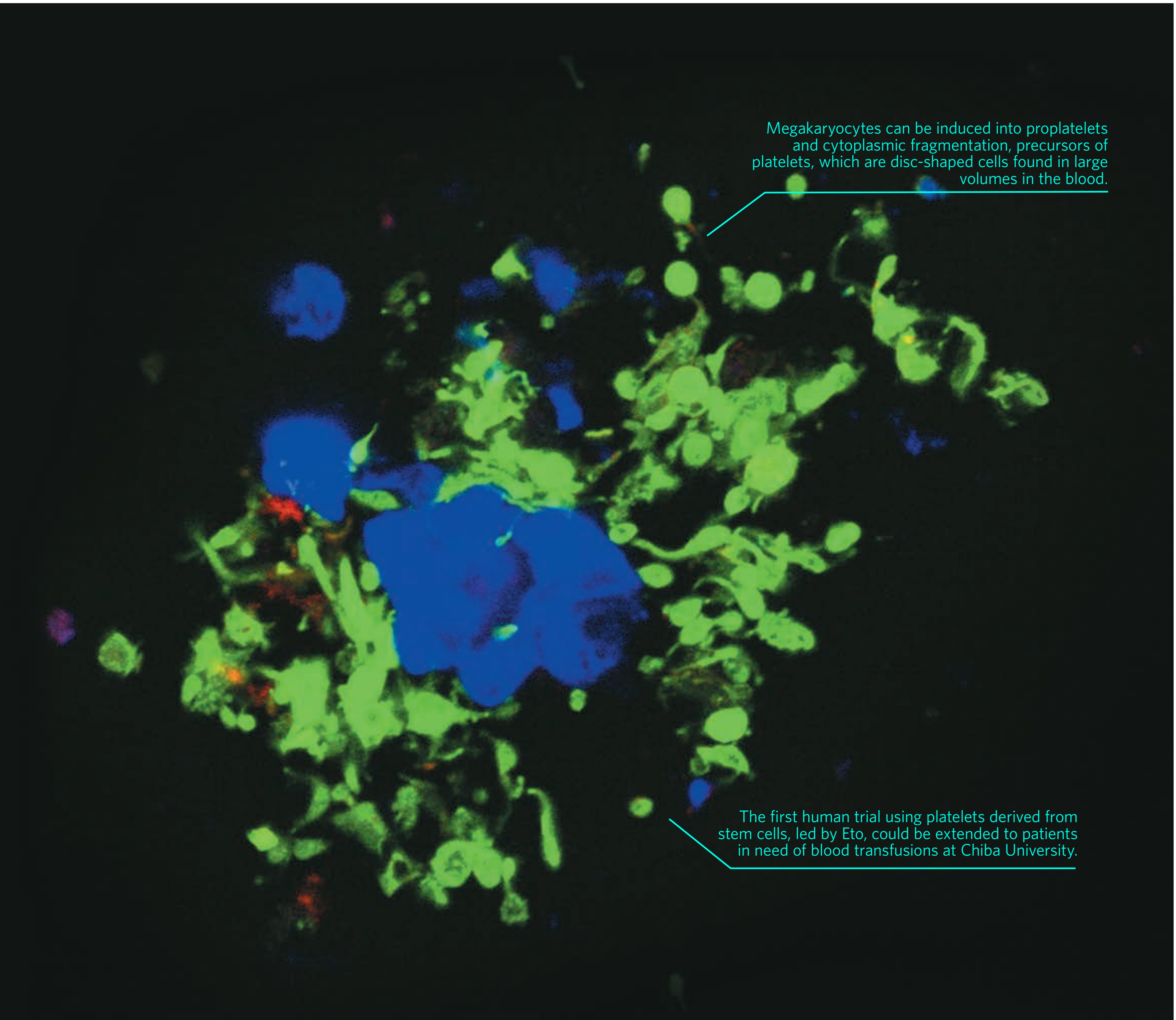
At the Integrated Research Center on Regenerative Systems and Diseases, Chiba University scientists are advancing both these avenues of stem cell research. Some researchers are focused on developing new kinds of therapies based on stem cells, while others are gaining important insights into disease biology. However, they all share the common goal of improving the lives of patients using stem cells as their tool.

The center, which opened in 2016, is divided into three main research groups. The first is dedicated to using stem cells found in the blood and brain to better understand disease and normal development; the second focuses on reprogramming tissue biopsies taken from patients to make disease-specific stem cells for drug screening; and the third is developing stem cell therapies for treating diabetes, heart disease and other disorders.

Center director, Atsushi Iwama, says their work covers a wide spectrum, from basic to clinical research. Yet despite different researchers adopting different approaches, they all work in a collaborative manner, holding regular group meetings and retreats where new data are discussed and new alliances forged.

COLLABORATIVE PARTNERSHIPS AROUND THE WORLD

The Integrated Research Center is also looking further afield to create a cross-disciplinary research network that spans the globe. It has already formed partnerships with other



Megakaryocytes can be induced into proplatelets and cytoplasmic fragmentation, precursors of platelets, which are disc-shaped cells found in large volumes in the blood.

The first human trial using platelets derived from stem cells, led by Eto, could be extended to patients in need of blood transfusions at Chiba University.

leading stem cell research groups in Japan, Singapore and the United States, and it hopes to build more international connections in the future.

One of those partnerships is with Kyoto University's Center for iPS Cell Research and Application, where Koji Eto has worked for years developing a protocol for making platelets from reprogrammed stem cells. Last year, Chiba University recruited Eto to join its new center. And while Eto will maintain a lab in Kyoto, where he plans to run the first human trial of platelets derived from stem cells, he hopes to expand the study to include patients needing transfusions at Chiba University Hospital.

Other notable members of the Integrated Research Center on Regenerative Systems and Diseases include Koutaro Yokote, a leading expert on a form of progeria known as Werner syndrome, and Chiaki Nakaseko, a world leader on a rare plasma cell disorder called POEMS syndrome. Yokote is making stem cells from patients with Werner syndrome to better understand the disease and find new drugs, while Nakaseko is focused on developing new kinds of transplantation therapies from stem cells derived from bone marrow.

These and many other world-renowned investigators make the new Chiba center an ideal place to work and train the next generation of scientists. "We hope to recruit many young people interested in stem cell research and clinical translation," Iwama says. ■

MEDICAL MYCOLOGY RESEARCH CENTER

MANIPULATING MICROBES FOR HUMAN HEALTH

Detailed investigations of host–microbe interactions could yield new therapies against infectious agents and autoimmune diseases

The human body is made up of a staggering 30 trillion cells or so. But just as numerous, if not more so, are the trillions of microbial co-inhabitants that teem in and on us. These commensal bacteria and fungi are essential to our well-being, and a distortion in the microbial balance can trigger a wide range of disorders, from acne to obesity.

Only recently, however, have scientists come to appreciate just how critical this collection of microbiota is for determining human health and disease. They are also becoming excited about the prospect of how manipulating this microbial ecosystem could form the basis for the next generation of life-saving therapeutics.

Led by Mitsutoshi Yoneyama, researchers at the Medical Mycology Research Center have launched a comprehensive research effort to dissect the intricacies of host–microbe interactions in the skin, lung, intestines and spleen.

"Dysregulation of host–microbe interactions can give rise to a wide variety of human disorders, including opportunistic infections, allergies and autoimmune disease," explains Yoneyama. "It is hence crucial to understand how hosts and commensal microbes communicate as a superorganism."

Creating a superorganism is an apt metaphor for what Yoneyama is trying to achieve because, through the melding of minds from across Chiba and around the world, the center can make a far greater impact than any individual scientist working independently. At Chiba University, the investigators come from the Graduate School of Medicine and the Graduate School of Pharmaceutical Sciences, while external collaborators are based in the United States, Germany and elsewhere in Japan. These scholars, together with others from around the world, convene each November at the Medical Mycology Research Center for the annual Global Network Forum on Infection and Immunity.

EXPLORING HOST–MICROBE INTERACTIONS

The team that Yoneyama has put together is roughly divided into four groups, each studying molecular interactions in different host–microbial systems. One, led by Shinobu Saijo and Yuumi Nakamura-Matsuoka, is focused on fungal infections in the skin of mice and humans; another, led by Koichi Hirose and Tomohiro Tamachi, is investigating the microbes — both good and bad — that reside in the respiratory tract. A third group, which includes Yoshiyuki Goto, is concentrating on the gut microbiome and how opportunistic intestinal infections gain a foothold; while the fourth, led by Akiko Takaya, is working on more basic mechanisms of immunological memory in response to microbial invaders.

"Results obtained from our projects will help efforts to create innovative new therapeutics against infectious diseases and will eventually lead to improvements in human health," says Yoneyama, whose own research focuses on the mechanisms of innate antiviral immunity.

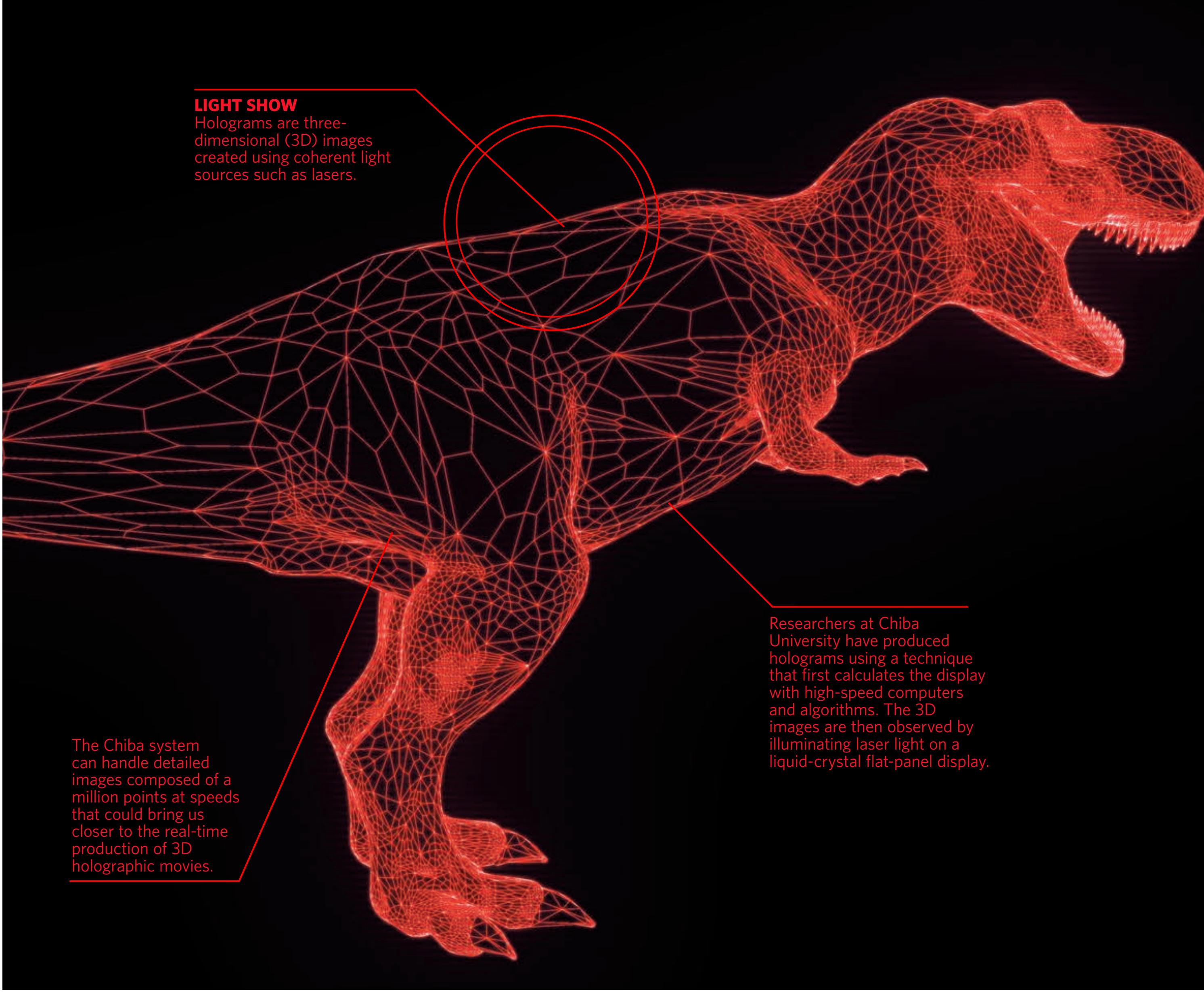
To assist all these research projects, investigators from each group have access to the Japanese government's network of core facilities — a resource known as the Joint Usage/Research Center, which is staffed by specialized researchers and technicians who can run state-of-the-art experiments, including with fungi and other microbes. A bioinformatics unit at Chiba led by Hiroki Takahashi helps with computational analyses. ■

FRIENDLY BACTERIA
Rod-shaped *Escherichia coli* bacteria line the intestines of humans and other warm-blooded animals. These bacteria are mostly harmless and play an important role in digestion, but some pathogenic strains can cause disease.

NEXT-GENERATION THREE-DIMENSIONAL DISPLAY AND MEASUREMENT

FUTURE IMAGES — MORE THAN MEETS THE EYE

Advances in three-dimensional image display and measurement techniques **have applications in multiple fields, from medicine to communication and entertainment**



Technologies based on three-dimensional (3D) image displays and holography may conjure up visions of science fiction, but the Next-generation Three-dimensional Display and Measurement program aims to make these advanced tools part of everyday life.

Holograms create true three-dimensional images, which allow the viewer to see an object from all angles. They are created using coherent light sources such as lasers, which can store the complex light interference patterns required to accurately recreate an entire 3D object in full color. However, the main drawback of holography is the immense computational burden of producing high-quality holograms, not to mention creating moving 3D video images in real time.

Leader of the 3D program, Tomoyoshi Shimobaba says his team is developing ultrafast algorithms and dedicated computers for holography to create the world's first real-time holographic 3D display system.

"These dedicated computers will have a computational speed three or four orders of magnitude higher than the household computers of today," adds Tomoyoshi Ito, advisor on the project. "Based on this dedicated technology, we will investigate holographic projection, digital holographic microscopy and ultrarapid holographic imaging techniques."

Among the team's recent successes is a small, inexpensive, zoomable holographic projection system, suitable for use in classrooms, medical applications and entertainment products. Shimobaba's team refined mathematical image manipulation techniques to ensure a high-resolution, non-grainy holographic image even when zooming in and out. The researchers are further developing algorithms that can reduce 'speckle noise' in reconstructed images to avoid degradation in image quality.

ONE IMAGE, MULTIPLE VIEWS

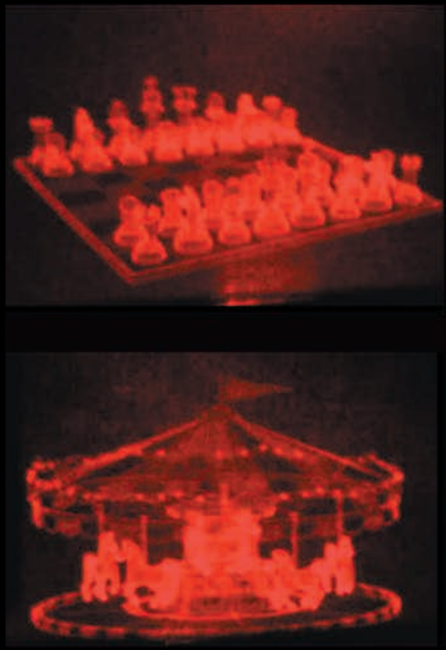
Another aim is to reconstruct large 3D images with a large viewing angle — something that is difficult to realize using current technologies.

"We are also developing accurate holographic measurement systems, which will be invaluable in medical science because they allow researchers to image and measure samples in 3D alongside visualizing moving phenomena in real time," explains Shimobaba.

In another exciting field of research, the team is exploring a form of 3D image creation called volumetric displays — the difference being that, while holograms can only be seen clearly by a few people at a time, volumetric displays can be viewed by multiple people from different viewpoints. And, in an even more challenging concept, they are trying to create multi-viewpoint images with plural information appearing in specific directions. In other words, one person standing at one place will see one piece of information, while another standing somewhere else will see completely different information.

"Our volumetric display simultaneously provides several observers with different information," explains project researcher Ryuji Hirayama. "This very exciting feature is quite new, and we are considering new applications for using it, such as developing multi-language signage for the Tokyo Olympics in 2020," he says. Such 3D displays may benefit from advanced aerial projection techniques, also under development by Shimobaba's team.

"Networking is the key to our success," says Shimobaba. "Many students who have graduated from our laboratory move on to conduct research in academia or in private companies, and we continue to work with them. In this way, we expand our project and build fruitful working relationships across academia and industry." ■



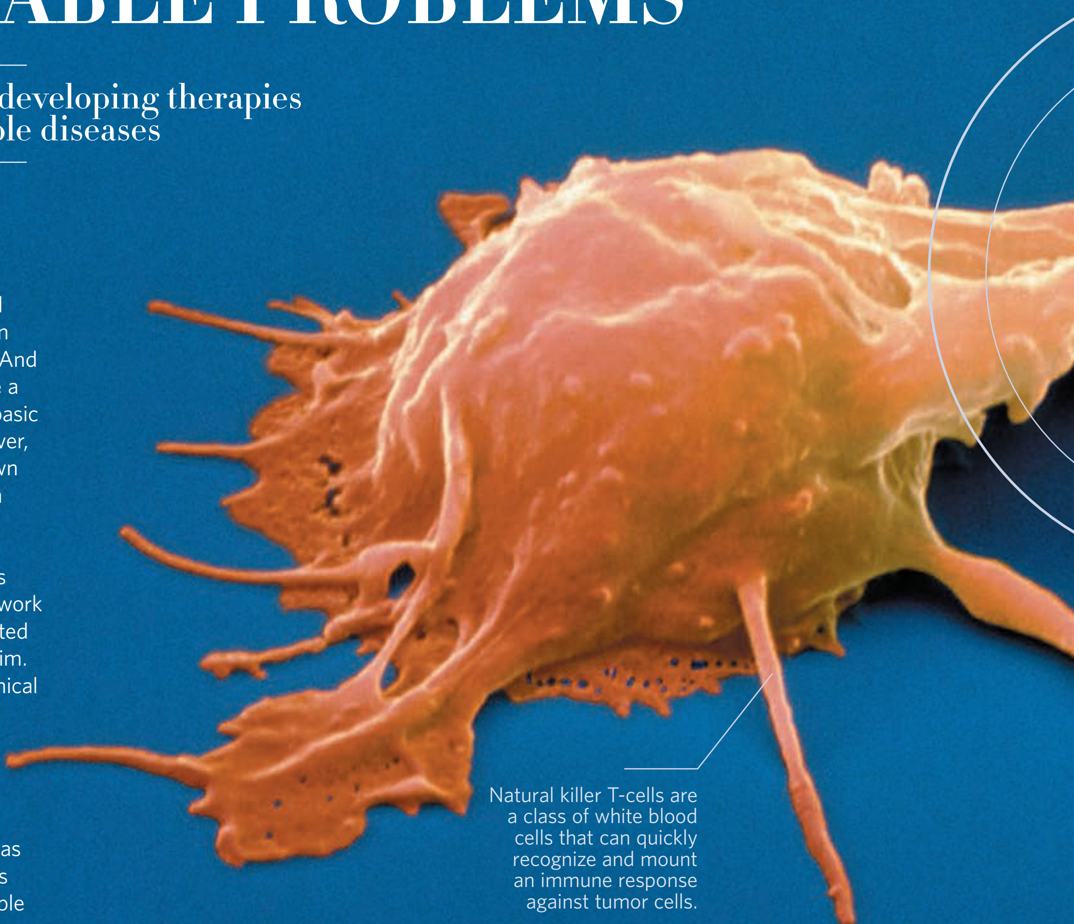
Computer-generated holograms of a chess board (top) composed of 44,647 points and a merry-go-round (bottom) made of 95,949 points created by researchers at Chiba University.

"OUR VOLUMETRIC DISPLAY SIMULTANEOUSLY PROVIDES SEVERAL OBSERVERS WITH DIFFERENT INFORMATION."

RESEARCH AND DEVELOPMENT NETWORK OF INNOVATIVE MEDICINE FOR IMMUNE RELATED RARE AND INTRACTABLE DISEASES

INNOVATIVE APPROACH OFFERS HOPE FOR INTRACTABLE PROBLEMS

The ReDenim network is developing therapies to treat rare and intractable diseases



Natural killer T-cells are a class of white blood cells that can quickly recognize and mount an immune response against tumor cells.

Scientists at Chiba University have a long track record of excellence in clinical research, particularly for investigations in patients with immune-related diseases. And Chiba University researchers have made a number of important breakthroughs in basic immunology and disease biology. However, connecting these two areas, a field known as translational research, has often been less successful.

That is a problem that Shinichiro Motohashi wants to fix. Motohashi leads Chiba's Research and Development Network of Innovative Medicine for Immune Related Rare and Intractable Diseases — ReDenim. The network is aiming to provide the clinical support and resources needed to take discoveries from the lab to the clinic.

In particular, ReDenim has singled out two disease areas for which there are currently no good treatment options — deadly forms of cancer, such as head and neck tumors; and rare diseases that each afflict fewer than 50,000 people in Japan, but collectively affect about 10 per cent of the population.

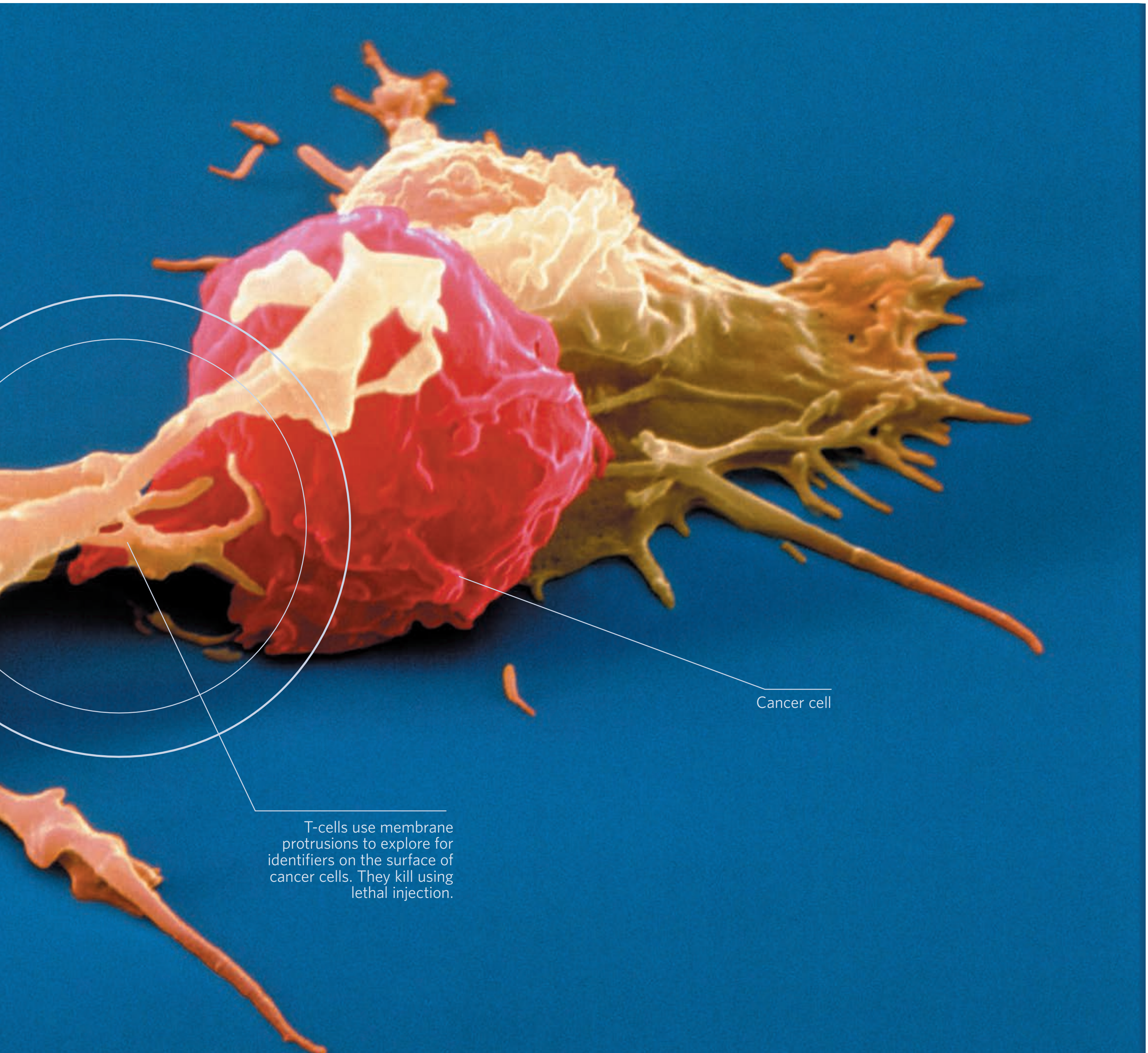
TWO-PRONGED APPROACH

Motohashi and Daiju Sakurai belong to the tumor immunity team, which intends to capitalize on Chiba University's expertise in developing cell-based immunotherapies. Their approach uses tumor-destroying natural killer T-cells to search for combination therapies that can further modulate the tumor immune microenvironment in a favorable way. They also intend to identify biomarkers that can predict how individual patients will respond to these treatments.

Led by Sonoko Misawa, the rare-disease team, including Masayuki Kuroda, Akira Suto and Kiyoshi Hirahara, is using immune-modulating drugs and gene therapies to address neurological syndromes, enzyme deficiencies, inflammatory conditions and recalcitrant fungal infections.

Kuroda is also working with the cancer team to develop a transgenic fat cell technology that has therapeutic applications for both tumors and the rare metabolism disorders he is studying.

Importantly, both teams will share research experiences, technology platforms and manufacturing facilities. "Sharing the know-how to treat each disease within the network will accelerate drug development," says Motohashi. And the two teams will also have access to support units at the university's Core Clinical Research Hospital, a designation granted to Chiba University under Japan's Medical Care Act in recognition of



T-cells use membrane protrusions to explore for identifiers on the surface of cancer cells. They kill using lethal injection.

its ability to apply basic science toward therapeutic applications. This support includes consultation services on issues such as intellectual property, project management, clinical trial design and other steps needed to fulfill the promise of translational medicine.

"Our ultimate goal is to form a therapeutic cluster that can be applied to a wide variety of rare and intractable diseases," Motohashi says. He foresees the infrastructure created through ReDenim being used to develop new therapies for common diseases, such as diabetes or lung cancer. Judging by the progress they have made so far, the researchers are well on their way to fulfilling their dream, and their potential is widely recognized. ReDenim has already forged collaborations with some of the world's leading experts in cancer immunotherapy and rare diseases, and is working with Japanese drug companies to partner on additional research projects. ■

SOFT MOLECULAR ACTIVATION FOR INTELLIGENT MATERIALS

CATALYZING THE FUTURE OF SMART MATERIALS

Catalysts developed from soft iodine, graphene and metal complexes could transform smart material technologies

The very idea of materials that change their shape or function as required sparks the imagination. Smart materials are impressive artificial molecules, often inspired by naturally occurring chemicals, which have the potential to revolutionize design. They undergo changes that are reversible and repeatable, meaning they can function as molecular switches, valves and sensors. Other smart materials include shape-memory alloys that return to their original shape after bending, metal-bearing polymers that can switch from insulator to conductor and drug-delivery systems that slowly release pharmaceuticals where and when they are needed.

Researchers at the Soft Molecular Activation for Intelligent Materials program are leading investigations into catalysts made from soft molecules that could one day transform smart material design.

Lead researcher Takayoshi Arai says the program is focused on developing powerful catalysts to create novel smart materials using three catalyst types. “Firstly, soft halogen catalysts, predominantly using iodine, can be used to develop highly targeted medications,” he explains. “A second type is ‘soft π-electron’ using carbon nanotubes and graphene, which would provide a unique reaction sphere for catalysis. The third type, ‘soft metal’ catalysts allow us to introduce soft elements such as gold and copper into target molecules.”

NEW CATALYST DESIGN

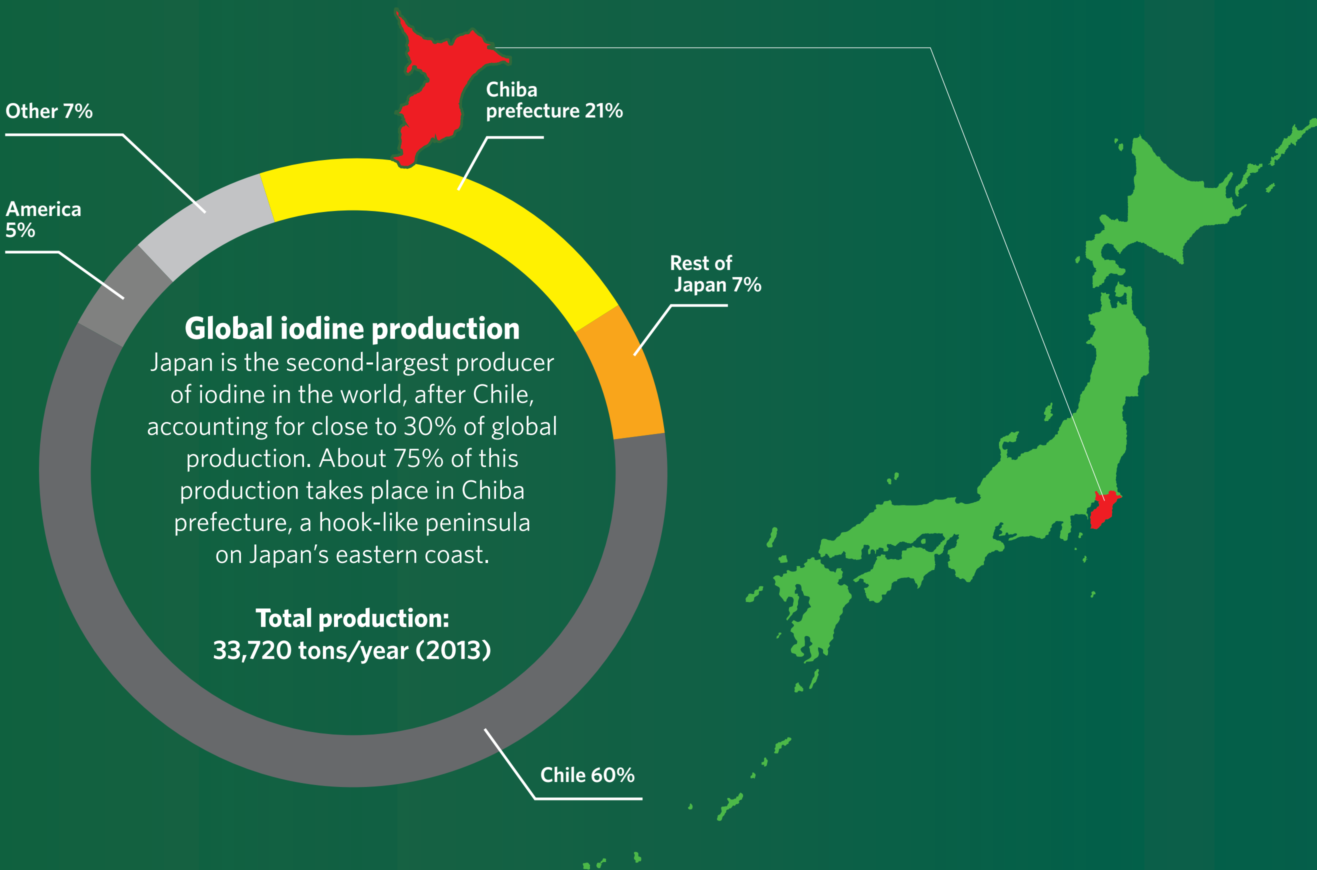
Arai says one of the main goals of the program is to create new asymmetric catalysts, which are used to generate large numbers of very specific molecules. Most biological molecules are chiral, meaning they exist in one of two mirror-image forms called enantiomers. Many drugs and smart materials use just one specific enantiomer, and so catalysts are needed to direct the chemical reactions toward forming the correct enantiomer.

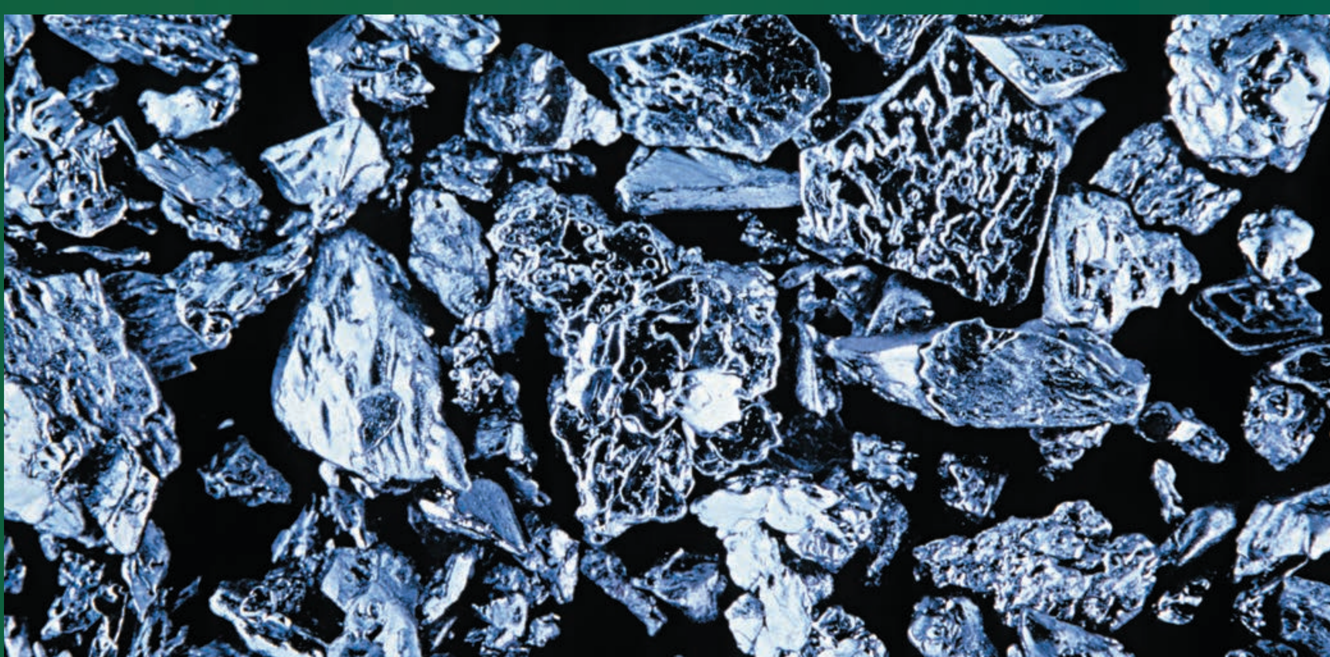
For example, iodine has been used to help synthesize specific enantiomers of cyclic and ring-shaped molecules. “We are lucky that Chiba prefecture in Japan is one of the world’s leading producers of iodine,” says Arai. “In fact, the Chiba Iodine Resource Innovation Center (CIRIC) will open at Chiba University next year. For this reason, a key goal of our program is to perfect iodine-based soft molecular activation.”

Recent success for Arai’s team includes the development of an aminoiminophenoxy-copper carboxylate catalyst that can trigger high yields of O-cyclized molecules. These can, in turn, be used to generate a particular chiral compound that is invaluable for use in antimicrobial and antiosteoporotic compounds.

“A crucial part of our research is designing catalysts that can be reused multiple times, thereby creating cost-effective, sustainable methods for generating useful compounds,” says Arai. His team recently designed a recyclable catalyst made from a zinc-polymeric ligand complex. The polymeric ligand allows the catalyst to be separated from the final product by a simple filtration process, meaning it can be reused — indeed, poly-Zn remained a stable and active catalyst for creating iodine-based ring-shaped molecules more than five times.

“By introducing soft elements to target molecules, our research will facilitate the development of smart materials with smooth and rapid responses,” says Arai. “We welcome anyone interested in research at the forefront of iodine-related soft molecular activation chemistry to come and work in this diverse and challenging field at Chiba.” ■





Despite its metallic appearance, iodine is a halogen.

CENTER OF EXCELLENCE FOR END OF LIFE CARE

PUTTING THE CARE BACK INTO END-OF-LIFE CARE

A new research program recognizes that care for the dying is an important issue for both public and professionals alike in a rapidly aging society like Japan

Japan is teetering on the precipice of a demographic crisis. Already, people over the age of 65 make up more than one quarter of the country's population. And the fraction of elderly people is only expected to rise in the years ahead — it is predicted that in 2060 two out of every five people in Japan will be senior citizens, putting huge logistical and financial strains on the country's long-term care systems.

The Center of Excellence for End of Life Care is trying to ease the impact of this skewed demographic by fostering cooperation between the public and the professionals who assist the elderly. The goal, says Center Director Mariko Masujima, is to develop a coordinated research strategy that ensures all older Japanese people can live out their final years in a comfortable and dignified manner with their wishes and aims fulfilled.

"We have to encourage people in our society to talk more openly about their own end-of-life care," she says. Only then will those facing imminent or distant death have the best quality of life in the time they have left — regardless of diagnosis, health condition or age.

The new center is housed within the Chiba Graduate School of Nursing, the oldest school of its kind in the country. It includes members from a wide range of interdisciplinary backgrounds, such as ethicists, engineers, health economists and doctors. These scientists are working together in four large research groups.

PREPARING FOR LATER LIFE

The first group is focusing on helping the elderly prepare for what lies ahead. In one project, they have developed a web-based education tool, which uses a range of animated scenarios to make users think about common end-of-life problems, such as a health emergency or the loss of cognitive functions. A prototype of the tool received favorable reviews in a small feasibility study and the team is now adding new features and functionality to make it more user-friendly.

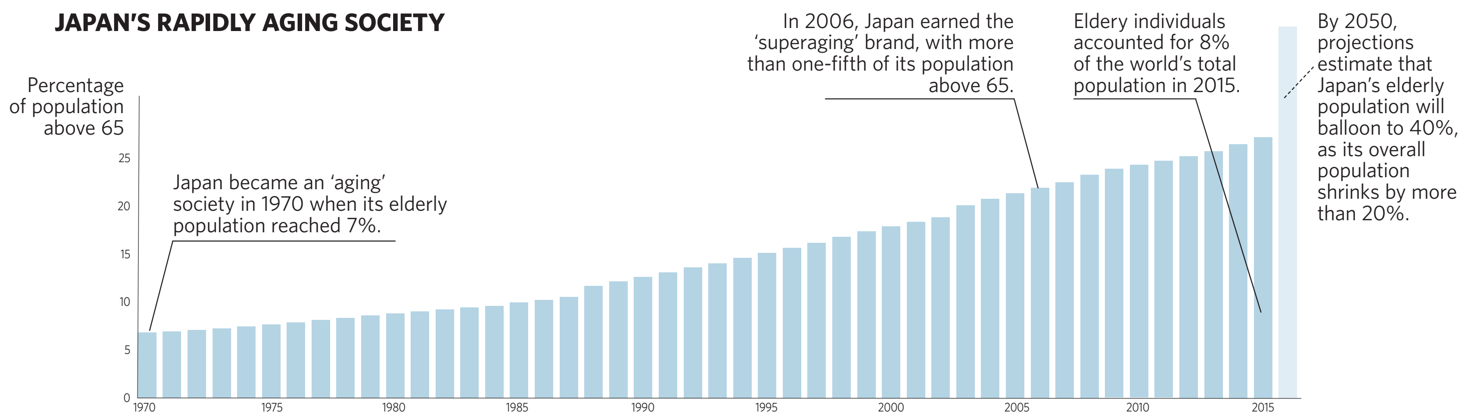
A second group at the new Center of Excellence is developing a technological surveillance system that deploys remote sensors to detect physical activity among older residents in long-term care facilities.

"By tracking changes of vital signs and physical activity in the elderly, the sensors serve as a tool both for research and for end-of-life care," explains Masujima. "They can help nurses and care workers pick up on discomfort that frail, older residents might not be able to express themselves." The system will soon be deployed for pilot testing.

The third research group is focusing on global outreach and has already established links with researchers in Thailand, Taiwan, South Korea, Northern Ireland and elsewhere in Japan, while the fourth group is developing educational materials — for both the public and for other health-care professionals.

"Students need a chance to think more about end-of-life issues," Masujima says. "Unfortunately, our health-care education focuses almost entirely on treating the living, but we also need to care for the dying." The new center hopes to make that a priority in the face of such a rapidly aging society. ■

JAPAN'S RAPIDLY AGING SOCIETY



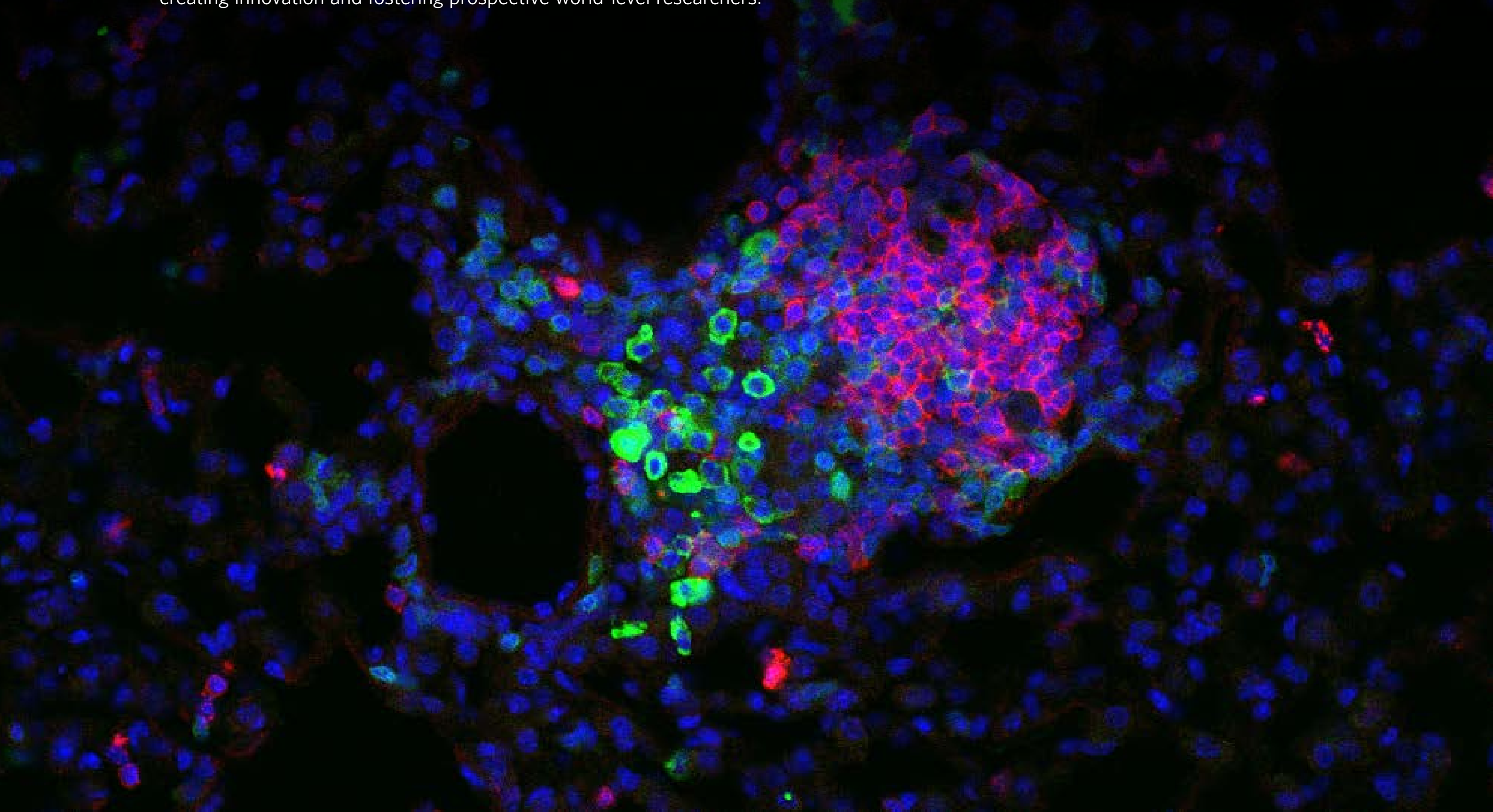
Source: Statistics Bureau, Ministry of Internal Affairs and Communications

INSTITUTE FOR GLOBAL PROMINENT RESEARCH

Chiba University is cultivating globally prominent research groups in three areas: the humanities and social sciences, science and engineering, and the life sciences. Through concerted efforts in these research areas — referred to as the Triple Peak Challenge — the university will promote innovation that paves the way for the next generation.

The Institute for Global Prominent Research (IGPR) was established in 2016 as a framework for the implementation of Chiba University's research strategy and its long-term goal of creating research groups that are novel, original and full of potential, and will play a key role in research at the university. IGPR is promoting research at two levels: the Research Division, which cultivates globally excellent research groups and forms world-prominent research bases, and the Next-generation Research Incubator, which nurtures the university's prospective priority research areas. The Management Division evaluates and selects research projects, and allocates strategically aggregated research resources based on each group's requirements and an evaluation of their progress.

Through the establishment of IGPR, Chiba University hopes to contribute to society by creating innovation and fostering prospective world-level researchers.



CHIBA UNIVERSITY

1-33 Yayoi-cho, Inage-ku, Chiba-shi,
Chiba 263-8522, Japan

www.chiba-u.jp
http://igpr.chiba-u.jp