

2016 SPECIAL ENGLISH EDITION



A Magazine from Japan

# Science Window



EXPLORE YOUR  
**WORLD**



Our Future with **ROBOTS**

Leaders in the Fight  
Against **INFECTIOUS DISEASES**

**+ MUCH MORE**



# Science Window

## Special Feature

### OUR FUTURE WITH ROBOTS

Introduction	4
Therapy by Robot: PARO the Robotic Seal	6
A Vet for Treasured AIBO Robot Pets	8

## Special Feature

### LEADERS IN THE FIGHT AGAINST INFECTIOUS DISEASES

An Indomitable Spirit: Satoshi Omura	12
Flashes of Inspiration in the Fight Against Infectious Diseases	14
The One Health Concept	15

## Nature Spotlights

Symbiotic Relationships: Clownfish and Anemone	2
Amazing Animal Secrets: Loggerhead Sea Turtles	10
Discover the Wonders of Weeds	16

## SCIENCE WINDOW

A science education magazine that children and adults can read together

The sense of excitement that comes from learning something that leaves us amazed or wondering “Why?” plants the seeds that help our minds grow into ones with a spirit of inquiry toward the world of nature. The Japan Science and Technology Agency (JST) publishes the science education magazine *Science Window* with the aim of encouraging children and adults alike to ask questions about their world and indulge their curiosity. This publication is distributed to elementary, junior high, and high schools across Japan, and is also available free of charge on the JST website.

This is a special English edition featuring articles from recent Japanese language issues that introduce cutting-edge robots and work in the fight against infectious diseases. Japan’s contributions in the areas of science and technology are important for the creation of a sustainable global society. We hope that people around the world with an interest in this area, as well as in education, will enjoy reading this magazine.

Takahiro Shibata

Director, Center for Science Communication  
Japan Science and Technology Agency



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## SYMBIOTIC RELATIONSHIPS: EXAMPLES FROM NATURE OF LIVING IN HARMONY

Boosted by the success of Pixar’s *Finding Nemo*, clownfish are very popular fish among the general public. Clownfish have a symbiotic relationship with sea anemone, meaning that they live together while providing each other synergistic benefits. The sea anemone has tentacles filled with nematocyst poison, which it uses to capture small fish and shrimp for food. Clownfish have a special layer of mucus surrounding their body that protects them from the nematocyst, enabling them to live within the anemones’ tentacles to protect themselves from predators.

There are various theories on the benefits anemone receive from clownfish. Anemone also live with algae and receive nutrients as a byproduct of the algae’s photosynthesis. Clownfish preen the anemone’s tentacles to remove parasites, allowing the anemone to spread them out to have a wider surface area to receive light for the algae’s photosynthesis. However, there are still many unanswered questions about the relationship between clownfish and anemone, and this remains a source of endless fascination for divers and marine researchers.

You may have heard about the symbiotic relationship between clownfish and anemone, but did you know that clownfish have the ability to change genders? All clownfish are born male and each anemone has one mating female and one mating male as well as a few smaller males living with it. When the female clownfish dies, the mating male turns into the next mating female, and the next largest male clownfish moves up in the hierarchy to become the mating male.

Clownfish lay their eggs within the anemone, and when the babies hatch they float close to the surface. After about a week, the unique white band of the clownfish begins to appear on their bodies, the protective mucus layer is completed, and they head for the bottom of the sea where they search out an anemone to live with by smell. Juveniles learn the smell of the sea anemone their parents lived with from the time prior to incubation inside the egg to immediately after incubation. This makes it possible for them to find a host sea anemone. **sw**



## Ocellaris clownfish

(*Amphiprion ocellaris*)

The ocellaris clownfish is a saltwater fish found mainly around Southeast Asia, including around the southern islands of Japan. It lives with a host sea anemone and finds ways to protect its "house."



## Giant carpet anemone

(*Stichodactyla gigantea*)

The giant carpet sea anemone lives in the western Pacific Ocean south of Japan's Amami Oshima Island. It attaches itself to rocks on the bottom of the ocean in the shallows of coral reefs. Although deadly to other fish, it is a safe and comfortable home for the clownfish that live within it.

Illustration: Kazunori Maeda

# Our Future with Robots

More and more robots are being utilized around the world and are revolutionizing fields from industry to health care, disaster response, and how we live our lives. Robots can now provide medical care for patients and work side by side with human workers, and there are also robots whose sole role is simply to make us happy. This article introduces some of these revolutionary robots that are shaping our world and invites you to think about what kind of relationship humans and robots will have in the future.



## DISASTER RESPONSE

*Robots we can depend on in dangerous situations*



◀ This worm-like, **multi-jointed robot** searches for victims buried in rubble. (TAUGIKEN Co., Ltd.)

**Quince** collects information on dangerous environments that humans cannot enter, such as disaster sites, with its outstanding mobility and measurement functions. (Tohoku University et al.)

▼ This **shape-changing robot** investigates nuclear power plant primary containment vessels with high levels of radiation. (Hitachi GE)



## EXPLORING OUR PLANET AND THE UNIVERSE

*Broadening the horizons of humankind*



▲ **Tri-TON2**, the autonomous unmanned submarine, conducts research on a seabed while moving slowly in the water and stopping at interesting areas. (Maki Laboratory, Institute of Industrial Science, The University of Tokyo)



▲ **HAKUTO PFM3** is a rover built to explore the surface of the moon. It is the subject of a Japanese project that brings together people of diverse backgrounds, including venture companies and universities. The rover is an applicant in the Google Lunar XPRIZE, a competition with an incentive prize that aims to explore the surface of the moon. (HAKUTO)



▲ Asteroid explorer **Hayabusa 2** en route to explore the asteroid Ryugu (JAXA)



◀ The famous **Mars Rover** explores the surface of Mars. (NASA)



## MEDICAL AND NURSING CARE

*Transforming hospitals and helping patients achieve their dreams*



▲ All in the name: **Honda Walking Assist** is attached at the waist and assists handicapped users when walking. (Honda)



▲ **da Vinci** supports doctors performing difficult surgeries. (©Intuitive Surgical, Inc.)



◀ **Robot Suit HAL** helps restore mobility in people who have disorders in the legs. The photo shows a user in Germany. (Prof. Sankai, University of Tsukuba/CYBERDYNE Inc.)



◀ **HOSPI** is an autonomous delivery robot that automatically transports drugs and other important objects in hospitals. (Panasonic)





▲ **NEXTAGE** works in tandem with human workers on factory assembly lines. (Kawada Robotics)



## INDUSTRY

Mechanizing and optimizing tasks for diverse businesses



▲ **MOTOMAN-VS100** is a spot welding robot used in automobile production. (Yaskawa Electric Corporation)



▲ **Strawberry harvesting robot** (National Agriculture and Food Research Organization)



◀ **Rice planting robot** (National Agriculture and Food Research Organization)



## ROBOTS IN OUR EVERYDAY LIVES



◀ The **Segway® PT**, which can be driven simply by shifting one's body weight, is increasingly being adopted for security work. (Segway)

◀ The multitasking **Pepper** can do everything from serving store customers to entertaining house guests in the living room. (SoftBank Robotics Corp.)

▼ **Roomba** makes cleaning the floor effortless and is a trustworthy ally for finishing chores. (iRobot)



▶ **RoBoHon** is a charming robotic telephone that can take care of all sorts of tasks. (Sharp, scheduled for launch in 2016)



▶ **KHR-3HV** is a humanoid robot that comes in a kit and can walk on two legs (Kondo Kagaku)



HOBBY ROBOTS THAT ARE FUN TO BUILD

▲ The constantly advancing **Robi** the walking robot (DeAGOSTINI JAPAN)



Collaboration/Photographs: Editorial Department of ROBOCON MAGAZINE, Ohmsha, Ltd. Photographs: Provided by Glory Ltd. (NEXTAGE) and the respective manufacturers and research institutions

Our future with **ROBOTS**



## EDUCATION AND RESEARCH

Robots that assist in robot research and teach us about robotics



▼ **HRP-4** serves as a platform for the development of a working humanoid robot. (Kawada Robotics, National Institute of Advanced Industrial Science and Technology)



▲ **NAO** helps people learn about the mechanisms of robots. (Aldebaran)

▲ **LEGO® MINDSTORMS®** Education EV3 serves as teaching material to learn about programming robots. (LEGO)

▼ **ASIMO** can react according to its surrounding environment. (HONDA)



▼ **Geminoid** looks exactly like a real person and helps us explore what it is to be human. (Intelligent Robotics Laboratory, Ishiguro Laboratory, Osaka University)





# Therapy by Robot

*PARO the robotic baby seal is attracting global attention for its therapeutic effects. We spoke to its developer Dr. Takanori Shibata, Chief Senior Research Scientist at the National Institute of Advanced Industrial Science and Technology (AIST).*

PARO IS SOFT  
AND CUDDLY AND  
CHARGES IN JUST  
TWO HOURS.



PARO's inventor  
Takanori Shibata

## **A robot whose sole task is to be a comforting animal companion**

### **What kind of robot is PARO?**

PARO was modeled to look like a baby seal. It is soft and its entire body is covered in artificial fur that people love to touch. It is an autonomous robot that makes seal noises, blinks, changes its facial expressions, and moves its head and limbs, acting as if it has a mind of its own. People experience joy and a sense of calm while interacting with PARO, and the robot has the potential to greatly increase quality of life for many users with medical needs.

### **What inspired you to create this kind of robot?**

I wanted to create a robot that could play a useful role in society. In the robotics field, many people with similar goals choose to develop industrial robots, but I wanted to make a personalized robot that could be used by the general public, and which could potentially create a new industry.

I began to think about pets and the vital role they play in society despite not having any direct output. Although most modern pets do not perform any specific helpful tasks for their owners, they still have a vital role in enriching the happiness of the people around them. Instead of a specific work function, they provide so many moments of happiness and tranquility.

## **Therapeutic effects that have been recognized around the world**

### **Could you tell us about PARO's popularity, which is growing overseas due to the role it can play in medical care?**

When PARO was launched for sale in Japan in 2005, close to 70% were purchased by individuals as pets, while only about 20% were purchased for use in medical care facilities. However, in Europe and America, PARO robots are commonly used as a therapeutic tool in medical facilities, and it is rare to see them purchased as pets in these regions.

## **Why has PARO been introduced into medical care facilities at a greater rate in Europe and America than in Japan?**

This may be the result of cultural differences, especially differences in our respective impressions of robots. In Europe and America, robots are perceived as tools built to perform tasks for human beings. In 2003, a survey on perceptions of PARO was conducted in seven countries across the world, including Sweden, Italy, Korea, and Brunei. The results revealed two distinct directions in the perceptions of its use—as a pet and as a therapeutic tool.

### **Is there any scientific proof of PARO's therapeutic effects?**

With regard to the animal therapy method, which aims to improve the symptoms of dementia and depression through the use of animals, I conducted tests on the brainwaves and blood flow in the brains of patients. The test results showed that touching PARO stimulated the patients' brains. Because of these effects, PARO was officially certified as a



*Children touching and talking to the PARO that is permanently featured at Tokyo's National Museum of Emerging Science and Innovation (Miraikan).*



*Touching PARO's soft fur and seeing its gentle expression helps alleviate anxiety in patients at medical facilities around the world, especially in Europe and America.*

medical device that provides neurological therapy to patients by the U.S. Food and Drug Administration (FDA).

### Drawing out memories and words

#### **PARO appears to have great potential for nursing homes and care facilities.**

After patients hospitalized for rehabilitation following a stroke use PARO, they are able to sleep well, and their numbers of calls to the nurses greatly decrease during the night. Once discharged from the hospital, continued use of PARO by patients in the home can greatly help the family members and carers who look after their needs. Its effect on patients commuting to hospital for treatment of dementia, such as memory clinics, has also been recognized.

#### **How exactly does PARO achieve these effects?**

While it may have limited functionality as a piece of machinery, PARO serves as a catalyst that helps to draw out the

memories and experiences of the people who use it. By stimulating the brain, it helps people remember who they are and express themselves naturally. Even people who have not spoken for years would naturally want to talk to PARO.

#### **Can PARO also play a useful role in education?**

PARO has been used for moral and emotional development of students at several public schools and special needs schools. Students speak to PARO about their difficulties with interpersonal relationships at the school clinic, and PARO also creates opportunities for students to talk with their friends in class. A significant number of children suffer from developmental disorders and I think PARO is a wonderful tool to help them work through their emotions and build up their social skills.

Going forward, I think that PARO can play a role in diverse aspects of society. In a company organization where only surface interactions are common, employ-

ees can gain greater understanding of each other through their interactions with PARO. PARO is full of so much hidden potential, and I am excited to find even more uses for it. [sw](#)

### TAKANORI SHIBATA

Chief Senior Research Scientist at the Human Informatics Research Institute of the National Institute of Advanced Industrial Science and Technology (AIST), and Professor at the graduate school of the Tokyo Institute of Technology. He is also a Visiting Fellow of the AgeLab at the Massachusetts Institute of Technology.







Hiroshi Funabashi in his workspace with some AIBOs waiting to be repaired.

# A Vet for Treasured Robot Pets

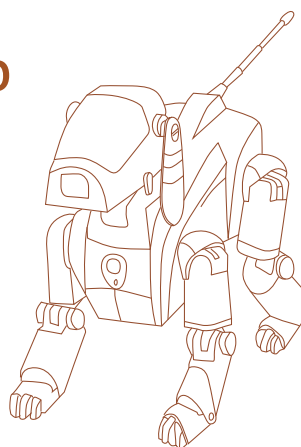
## AIBO Robots Get a Second Chance at a Tokyo Repair Shop

*Pet owners would do anything for the health of their beloved companions, and that includes owners of AIBO robots. The oldest robots are now over 16 years old, above the average life expectancy of a living dog, but talented repairmen allow the robots to live on.*

Sony took the world by storm in 1999 when it began selling AIBO, the first dog-like, consumer robot that was a pet truly fit for the new millennium. Sony continued to produce a total of five wildly popular models of AIBO until 2006, when production ceased. In

March 2014, Sony announced that it would no longer provide service support for any of its AIBO models, leaving AIBO owners desperate to find an alternative source of repairs.

AIBO owners have found a refuge at the repair shop of A·FUN Co., Ltd., a company established in July 2011 by former Sony employee Nobuyuki Norimatsu, who once worked on building Sony's service and overseas





sales network. A·FUN takes on repair requests for products that no longer receive support from their manufacturers. Located in a single room in a building close to the Keihin Canal in Tokyo, the repair shop's floor is littered with well-loved but dated electronics in for repairs, including a dual cassette player and karaoke machine.

### Veterinary Repairs

Since Sony's 2014 announcement about discontinuing support for AIBO, repair requests for the robots have sharply increased at A·FUN. Norimatsu first received a repair request for an AIBO in 2013. The owner was an elderly woman who was about to enter a nursing home and she was desperate to have her broken AIBO fixed so she could bring it with her. An acquaintance of the woman asked for Norimatsu's help, and he accepted, promising to do his best despite it being his first such repair job.

Norimatsu enlisted the help of Hiroshi Funabashi, a former Sony repair technician introduced by a colleague from his days at Sony. Funabashi accepted the job because of Norimatsu's firm conviction that the robot could be fixed. The two men tackled the challenge of the broken AIBO, with issues that mostly stemmed from broken moving parts and the deterioration of the battery. Due to this, the AIBO's legs would not move from the joints to the feet and its neck was slightly bent.

After three months of continued efforts, the men succeeded in bringing the AIBO back to "life." "After we returned the AIBO, I got a call directly from the owner herself. She was crying tears of joy because she loves her AIBO like one of her own children," Funabashi recalls. The AIBO repair success story quickly spread among the AIBO owners' community and soon repair requests were coming in one after another. Norimatsu now has a backlog of 250 AIBOs waiting to be fixed.

### Utilizing all available resources to tackle challenges

"Anything can be fixed." This is Norimatsu's motto when it comes to repair



*Nobuyuki Norimatsu named his company A·FUN to convey both the fun and importance of monozukuri, the Japanese concept of pouring one's heart and soul into the pursuit of ultimate craftsmanship.*

work. "If we can't find a replacement part, all we have to do is create a new one. We're able to manage somehow." Norimatsu's approach to repairs is reflective of monozukuri, the Japanese culture of pouring one's heart and soul into the pursuit of craftsmanship of the highest caliber.

However, sometimes manufacturers can fall behind in providing repair services. Manufacturers tend to focus too much on providing uniform services, so they sometimes say something cannot be fixed if it does not meet their own repair conditions. "But that's just the manufacturer's ego at work," asserts Norimatsu.

Norimatsu and his colleagues have made it their mission to find new and ever better ways to repair AIBO robots. They face numerous challenges, including the fact that each of the

five generations of AIBO was made differently. Moreover, AIBO are designed so that the screws for disassembly are hidden to every extent possible. For one repair job, Norimatsu and his colleagues had to meet an AIBO designer to find the locations of the hidden screws. They also found a website created by an AIBO fan in the United States that shows how to disassemble the head.

To find replacement parts, Norimatsu and Funabashi have various methods, including searching Akihabara, Tokyo's electronics district, and placing bids in internet auctions. Rather than throwing them away, some owners of defunct AIBOs allow their beloved robots to become "organ donors" through disassembly to take body parts. "Before taking the AIBOs apart, we hold funerals for the robots to allow their souls to return to their owners," explains Norimatsu.

Having gained the know-how to repair AIBO, Norimatsu and his colleagues are eager to expand their repair network. Their efforts include hosting seminars for other engineers who are interested in getting involved.

### Repairing items for which there can be no replacement

When an item breaks, people have the option of either buying a replacement or having it repaired to continue using it. Although in some cases it is cheaper to buy a replacement, many people opt for repairs due to their emotional attachment to the object. "Something full of memories has a value of its own. This is why people want to fix things when they break," says Funabashi. "When I repair an item, I do more than just mend the item itself. I also heal the heart of the customer," says Norimatsu. There can be no replacement for AIBO robots in the hearts of their owners, and luckily Norimatsu and Funabashi have the skills and passion to restore these beloved pets. **sw**



*Hiroshi Funabashi carefully repairing an AIBO after disassembly. At first, Funabashi did not even know how to take the AIBO apart.*



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**AMAZING  
ANIMAL  
SECRETS**

# Loggerhead Sea Turtles

*Exploring the mystery-filled, long life of the loggerhead sea turtle*

**A**t the Port of Nagoya Public Aquarium in Japan, children eagerly crowd around the massive glass window to stare excitedly at the loggerhead sea turtles leisurely walking along the sandy beach inside. “Wow, look how big they are!” “I could probably ride on their back!”

In 1995, the Port of Nagoya Public Aquarium became the first indoor facility in Japan to successfully breed and utilize artificial incubation for loggerhead sea turtles. The aquarium’s donut-shaped tank surrounding a rock hill in the middle is connected to an artificial sandy beach. The carefully constructed space provides an environment tailored to encourage mother turtles to come ashore during the egg-laying season of May to August to lay their eggs.

Turtles are popular subjects of Japanese folklore, as well as tales and legends all over the world. Everyone knows that turtles live a long time, with one saying in Japan even going so far as to state, “Turtles live 10,000 years.” But how long do sea turtles actually live? Caretaker Seiju Kobayashi says, “Visitors ask me that question all the time but I actually cannot answer it. The truth is that we still don’t know how long they live.”

The average lifespan of the turtles is not the only challenge for researchers. The gender of a baby sea turtle cannot be determined for many years after birth. According to Kobayashi, “You can’t tell the difference in terms of appearance until the turtles reach around seven to eight years old.” Interestingly, the ratio of male and female sea turtle babies born differs based on the

temperature of the sand during the egg-laying season. With 29 degrees Celsius as the demarcation line, sand with a temperature of between 30 and 34 degrees will yield more females, while sand between 26 and 28 degrees will yield more males. “At the aquarium we artificially keep the temperature between 29 and 30 degrees Celsius to ensure roughly half the turtles born are males and the other half females.”

In addition to the donut-shaped tank with the artificial sandy beach, another tank holds roughly one year old baby sea turtles and their mothers. Under the watchful care of their parents, who charmingly fidget with their front flippers, the baby turtles swim around the tank without a care in the world.

Most of the artificially incubated baby sea turtles are released into the wild, but a few remain at the aquarium. “We release them to increase the population, which has been declining. The other reason is to research their habitat,” explains Kobayashi. A joint study initiated by the National Oceanic and Atmospheric Administration (NOAA) of the United States in 2003 has attached transmitters to loggerhead sea turtles around one year of age and tracked them by satellite. The assistance of the training vessel *Aichimaru* of Miya Fisheries High School in Aichi Prefecture has been enlisted to help release the baby sea turtles and track their journeys. “It is extremely important to monitor marine life for long periods of time.”



Female



Male



## LOGGERHEAD SEA TURTLES

The loggerhead sea turtle is a species found widely in the Pacific Ocean, Atlantic Ocean, Indian Ocean, and the Mediterranean Sea. The group living in the North Pacific uses sandy beaches on Japan's Pacific Coast south of Fukushima Prefecture and the Sea of Japan south of Niigata Prefecture as spawning grounds. Loggerhead sea turtles have a larger head than other sea turtles and their shell is dark brown with a heart shape.



**Top photos:** Male adult loggerhead sea turtles have longer tails than females. **Bottom left:** When the eggs are dug up and taken to the artificial incubation area, the tops are marked so they are not mixed up. **Bottom right:** During the egg-laying season turtles come ashore from the aquarium tank to an artificial sandy beach, enabling 24 hour monitoring of the egg-laying process.

**SOME MOTHER TURTLES LAY EGGS FOR 14 CONSECUTIVE YEARS!**



However, the environment faced by wild sea turtles is increasingly severe, with harsh conditions including disruption from fishing activities, marine pollution, declining sandy beaches due to development, and natural disasters such as torrential rain and typhoons.

What can you do to help the sea turtles? Kobayashi draws attention to the fact that it is essential to make rivers cleaner. "If rivers are clean, the ocean will be too. I want people to think about the interconnectedness of people and wildlife." We must all remember that our actions directly affect the animals around us. [SW](#)

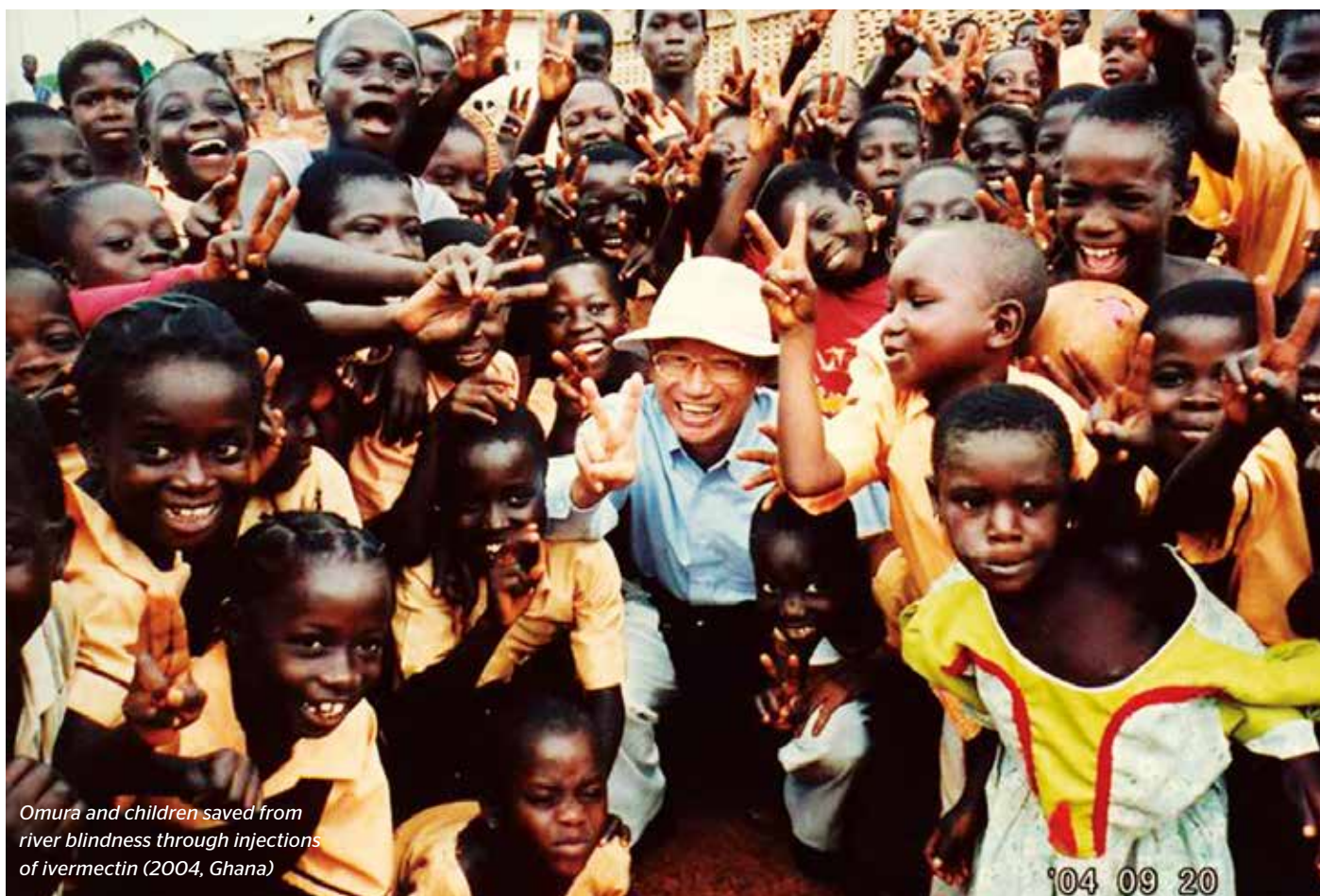


## PORT OF NAGOYA PUBLIC AQUARIUM

The aquarium raises four species of sea turtles: loggerhead sea turtles, green sea turtles, hawksbill sea turtles, and olive ridley sea turtles. Check out their website at the link below for more information on their program and

visiting information if you are in Japan!  
<http://www.nagoyaaqua.com/english/>





Omura and children saved from river blindness through injections of ivermectin (2004, Ghana)

# An Indomitable Spirit

## The Life and Research of Nobel Laureate Satoshi Omura

*Professor Satoshi Omura, Distinguished Emeritus Professor of Kitasato University, received the 2015 Nobel Prize in Physiology or Medicine for his work developing preventive drugs for infectious diseases. In this feature, we look back on his life and track his career and achievements.*

### **The discovery that saved millions of people**

As a Nobel laureate, Professor Satoshi Omura was recognized for his work toward the discovery of the chemical substance known as ivermectin. Medicine created using ivermectin protects people in the tropics from debilitating and deadly diseases. Taking just one tablet once a year serves as a preventive measure against dangerous tropical diseases such as onchocerciasis (river blindness spread by black flies) and micro filariasis (a parasitic disease caused by infection with roundworms). Roughly 300 million people are now taking the medicine.

Ivermectin is produced by microorganisms living in the soil near a golf course

in Kawana, Ito City, Shizuoka Prefecture in Japan. Although scientists have searched for similar microorganisms around the world, they have not been found anywhere outside of Kawana. Ivermectin was developed by Omura in collaboration with the American pharmaceutical company Merck. It has become an effective drug for human beings as well as a wide range of animals.

### **Finding inspiration for his studies**

Omura was raised in the countryside in Yamanashi Prefecture. As the eldest son of a farming family, he worked hard on the farm composting, planting and harvesting rice, working with silkworms, and catching eels in the river.

This helped him learn about the wonders of ecology. He only began studying in earnest during his third year in high school, and decided to go to Yamanashi University. After graduating, he became a teacher at a night school, teaching chemistry and physics. Inspired by his students who somehow managed to balance their studies while working in factories, Omura decided to study at graduate school at the Tokyo University of Science while working nights. Upon graduation, he began to conduct research in fermentation science as an assistant at Yamanashi University. He learned about the power of microorganisms there, leading to his fascination with the subject.





**Above:** Omura at a press conference with Professor William C. Campbell, with whom he shared the 2015 Nobel Prize (Jiji Press)

**Right:** Professor Omura during his junior high school days

**Far right:** The turning point of Omura's life was meeting Professor Max Tishler at Wesleyan University



## “No matter how many times I failed, I never lost hope”

— Satoshi Omura

### Research in Japan and the United States

Next, Omura entered the Kitasato Institute, where despite his prior career he was treated just like a new university graduate. Eager to prove himself, Omura arrived every morning at 6 a.m. and zealously tackled each difficult project that came his way. His dedication was soon recognized at the Institute, and by also capitalizing on the techniques he learned at university he was able to achieve excellent research and results.

Omura's determination grew stronger by the day, and he challenged himself to write a paper in English to submit for publication. His paper received attention, and he even received a visit from a famous American researcher. From then on, Omura set his sights on becoming a researcher who could play an active role in the international arena.

The greatest turning point of his life came when he went to pursue further studies at Wesleyan University in the United States. Professor Max Tishler, who became his supervisor, championed Omura and drew him into interactions and exchanges with world-class researchers including Nobel Prize winners. Omura learned the importance of collaboration at Wesleyan, and was able to expand his personal

network of fellow researchers.

After he returned to Japan, Omura committed himself to academia-industry collaboration with Merck. The research laboratory headed by Omura extracted substances that are useful to human beings from chemical substances that are produced by microorganisms, and expanded its research work with Merck to develop these substances into pharmaceutical drugs. During this time, Omura placed emphasis on something his grandmother repeated to him since he was a young boy—to be useful to others. Instead of conducting research purely for its own sake, he began to think constantly about how he could apply his research to helping people.

### Fostering outstanding researchers

Omura racked up achievement after achievement in his research on the chemical substances produced by microorganisms, and became a world-class researcher. He also suffered many disappointments along the way while building up this track record of success. According to Omura, “No matter how many times I failed, I never lost hope. I always approached my research work with the conviction that I would succeed.”

Omura taught students and researchers

using the expression “Sincerity can move heaven and earth,” meaning that pouring your heart and soul into tackling something will lead to positive results. Omura offered his firm support to all motivated, hardworking people, and did not discriminate based on gender or academic pedigree. For example, Yoko Takahashi, who worked as an assistant in Omura's research laboratory after graduating from high school, had her hard work recognized by Professor Omura. She then earned her doctoral degree and became a professor at Kitasato University. The Omura laboratory has fostered 31 professors and 120 students who have obtained doctoral degrees. Academics who can boast such a track record are extremely rare. **sw**



### RENSEI BABA

Science journalist and author of numerous publications on the work of Satoshi Omura, including *Satoshi Omura: The Chemist*

*Who Protected 200 Million People from Disease (Chuokoron-Shinsha, Inc.).*

# Flashes of Inspiration in the Fight Against Infectious Diseases

*Shunichi Takebe, Science Journalist*

The history of mankind has been defined by a battle with microbes. Even after entering the 21st century, it has been difficult to take an optimistic view toward this battle. This is clear from the turmoil caused by new forms of influenza and the Ebola virus disease. However, human beings have obtained powerful weapons in the form of vaccines and penicillin, which have saved millions of people. Their development started due to fortuitous flashes of inspiration brought on through a previous incident. In this article, we will take you on a time warp to these moments of inspiration.

## The boy and the cowpox inoculation experiment

The scene of the pioneering vaccination experiment is set in a hospital in Gloucestershire in the western part of England at the end of the 18th century. Dr. Edward Jenner pierced the arm of a young boy, James Phipps, planting the pus taken from the cowpox boils of Sarah Nelmes, a milkmaid who had cowpox, an infectious disease similar to but milder than smallpox that can spread through contact with cows.

Eight days later, symptoms similar to that of the milkmaid appeared on the boy's arms. After leaving him for one and a half months, Jenner inoculated the youth with pus from a smallpox patient. Despite this, Phipps showed no signs of smallpox infection, showing the significance of Jenner's experiment. The word vaccine came into use to describe this method because of the experiment's connection to cows. The word "vaccine" has its roots in the Latin word for female cattle.

The cowpox inoculation that was carried out on Phipps, the son of a servant, would probably have been criticized today for being a bold new experiment on a human subject. However, Jenner had been developing the approach for many years. As a youth training to become a physician, he heard that milkmaids do not catch smallpox. Although some doctors practiced the human smallpox inoculation method, which involved giving patients a light case of smallpox, this had led to death and brought about an epidemic. It was Jenner who was inspired with the idea of preventing serious smallpox infections by giving people a light cowpox infection. The last naturally occurring case of smallpox was observed in a Somali man in 1977, signaling the eradication of a disease that had caused pockmarks, suffering, and death in millions of people.



*Jenner and his cowpox  
innoculation experiment*

## The summer holiday that led to the discovery of penicillin

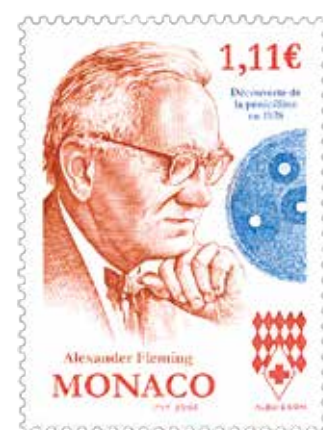
Alexander Fleming, a microbiologist at St. Mary's Hospital in London, liked to amuse himself by working with bacteria. In the summer of 1928, he went for a long vacation while leaving cultured *staphylococcus aureus*, a harmful type of bacteria, standing in its container. When he returned, he was surprised to find that blue mold had grown and ruined his bacteria for experimenting.

Spores of the fungus *penicillium notatum*, which were being cultivated in another laboratory, had floated into Fleming's culture dish. When he looked carefully, he found that a colony of *staphylococcus aureus* had dissolved only around the green mold. This prompted Fleming to investigate if the fungus was releasing a substance that kills bacteria.

Seven years before in another chance event, Fleming sneezed during a culture experiment and discovered that his mucus had dissolved bacterial colonies. He realized that the enzymes contained in nasal mucus and tears (lysozyme) had an antibacterial effect. But Fleming was motivated to find an even more powerful substance than the relatively weak lysozyme. Already familiar with bacteria through his daily observations, Fleming was able to realize there was something of note about the invading *penicillium* mold that had ruined his experiment materials.

However, Fleming only thought of using penicillin as an antiseptic. The true value of penicillin was discovered by pathologist Howard Florey and biochemist Ernst Boris Chain. The two generated penicillin, elucidated its chemical structure, and enabled its mass production. This heralded the arrival of the era of antibiotics, which dramatically reduced the number of victims of infectious diseases. Fleming, Florey, and Chain shared the Nobel Prize in Physiology or Medicine in 1945 in recognition of their important work.

30 years after winning the Nobel Prize, Chain traveled to Japan and I had the opportunity to interview him. He had built up significant distrust of journalists out of frustration with their fixation on lauding Fleming as the great man who created penicillin. Although he respected Fleming as the person who discovered penicillin, he lamented the fact that he and Florey were neglected by the media despite their role in developing it to its true potential. **SW**



*Alexander Fleming*



# The One Health Concept

*A rise in communicable diseases is an inevitable result of increasing human interaction around the planet. Can the One Health concept help protect our health in this globalizing world?*

## Communicable diseases that cross borders and species

The increasingly active cross-border movement of people and goods has caused communicable diseases that were once thought to be endemic diseases, such as the Ebola virus disease, to spread around the world. Professor Mitsuo Kaku, who researches the control of communicable diseases at the Tohoku University Graduate School of Medicine, raises alarm bells about the growing risk posed by the globalization of zoonoses (diseases which can be transmitted from animals to humans). Many people focus their attention on transmissions from other people, but new influenza viruses can be transmitted from animals such as pigs, and in the case of Ebola can be transmitted from bats. In addition, a large number of pathogenic microorganisms can enter our bodies from soil, plants, and lakes that we come into contact with. If we do not properly consider the role of animals and the environment in communicable diseases, we will not be able to control them.

## Making One Health a part of our shared culture

Among scientists and doctors, the One Health concept is garnering attention as a comprehensive way of thinking about the connection between human health and animals and the environment. In 2004, wildlife protection societies in the United States proposed the idea of “One World, One Health” in which various research domains around the world serve as a bridge to better health.

Professor Kaku likes to relate the One Health concept to the phrase “all living things,” which appears in *Phoenix*, written by Osamu Tezuka, the beloved Japanese comic book writer who also created the famous Astro Boy character. “People, animals, plants, and the microorganisms that cause communicable diseases – these can all be described under the label ‘all living things.’ We are all connected, and we must all be able to coexist.”

Viewing communicable diseases from a worldwide point of view, Professor Kaku asserts that a new culture is necessary to combat communicable diseases. “Can we as humans acquire the skills needed to act while thinking carefully about the environment surrounding us, and then react calmly to the presence of pathogenic microorganisms and find ways to co-exist? Within this philosophy of One Health, a culture is needed for sharing knowledge that allows people around the world to live better lives.”

## Protecting global health starts with washing your hands

Professor Kaku has led a seminar instructing children about the importance of washing their hands for more than 10 years. The

seminar also includes explanations on how microorganisms cause communicable diseases, and the participants are shown bacteria cultivated in a Petri dish. A popular part of the seminar comes when children are given the opportunity to use a microscope to view the microorganisms from their own mouth or nose on a cotton swab. A picture is then presented to the children with the title “This is Your Bacteria!” which always provokes excited reactions.

“The reason why I give out these pictures is that I want children to think about the organisms that we coexist with when they wash their hands. I want them to know that by washing their hands, they are making their own contribution to the health of all living things, protecting the people they love, and making society a better place.” **SW**



*Children excitedly viewing their own bacteria under a microscope at a handwashing seminar.*

## MITSUO KAKU

Tohoku University Graduate School of Medicine professor involved in the control of and diagnostic methods for communicable diseases, as well as crisis management.



# Discover the Wonders of **Weeds**

**Y**ou can find weeds everywhere - next to roads, when you go hiking, inside cracks in the sidewalk, and, often, right under your feet. When you think about weeds, you probably think of some dull, bothersome grass, but if you take a closer look you will discover a world of fascinating complexity and beauty.

Tokyo University of Agriculture's Dr. Rie Miyaura, who is also Secretary of the Weed Science Society of Japan, is enthusiastic about encouraging people to look to weeds as they explore their relationship with the nature around them. She notes that many weeds look alike, and it is difficult to distinguish weeds without flowers. Thus, for beginner observers she suggests using an identification guidebook and picking weeds that have flowers, taking them home, and recording observations about them. She adds that making a booklet of specimens would make an excellent summer project for students. Follow our handy instructions below to prepare your own specimens and take your first steps as a scientist!



## Weeds of the World

The fascinating thing about weeds is that due to their hardy nature and ability to spread quickly, the same or similar varieties of weeds can be observed around the world. How many of these weeds that grow in Japan have you seen? What are they called where you live? **sw**

## ■ HOW TO PREPARE A SIMPLE SPECIMEN

(1)

**Use wide tape** to stick the weed to a sheet of paper in the desired shape.

(2)

**Record your observations** about the weed, such as its name, the date, the location, type of environment, and sketches of the flower.

(3)

**Insert a piece of newspaper** in between the sheets of paper, and change every day for a period of about three days. After that, repeat 2-3 times every two days until there is no longer any moisture.

### Henbit Deadnettle

Japanese name: *Hotoke-no-za*  
(lit. "Buddha's seat")

*This plant got its Japanese name because it appears as if the Buddha is sitting on the flowers above the leaves. The English name is much fiercer!*



### Creeping woodsorrel

Japanese name: *Katabami*

*Creeping woodsorrel is sometimes called "Sleeping Beauty" in English. In one regional dialect of Japanese, it is called "Sparrow Hakama." Hakama are flowing, divided pants worn in traditional Japanese clothing.*



Writer: Fumi Hayana / Photos: Hiroaki Kamei



### Shepherd's Purse

Japanese name:  
*Nazuna*

*The leaves are in the shape of rosettes, and its berries have a heart shape. It makes a sound when shaken, and many Japanese children love to play with it. Shepherd's Purse is used in Japanese cuisine, and was also once utilized as medicine.*



### Persian Speedwell

Japanese name:  
*Oinunofuguri*

*One of the lovely flowers that brings color to the world in spring. Originally from Asia, it has spread to countries all over the world. Have you had a chance to see it for yourself?*