

Rediscover JUNKAN

Monthly JP pavilion

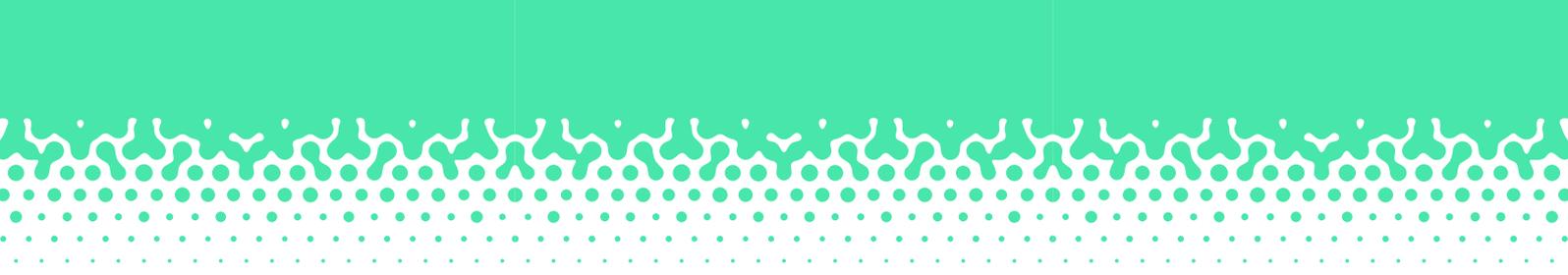
Feature

Little Hard Workers

Issue

04





From Our Bodies to Outer Space, Observing the Cycles Everywhere.

issue **04**

Little Hard Workers

Feature



“Microorganisms Are With Us at This Very Moment.” We Asked Kohei Ito From Biota About the Symbiotic Relationship Between Humans and Invisible Things

Invisible to the eye, yet undeniably present everywhere. Kohei Ito emphasizes the necessity of microbial diversity in urban areas.

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Did Microorganisms Come from Space? Thinking about the Cosmic Scale of Cycles

Can microorganisms survive in extreme environments? Let's explore the various theories related to the origin of life.

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Harnessing Methane Fermentation Power: Meet the Biogas Rangers Saving Our Planet!

The Biogas Rangers, who save the Earth with the power of fermentation! Behold the power of methane!

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“Microorganisms Are With Us at This Very Moment.” We Asked Kohei Ito From Biota About the Symbiotic Relationship Between Humans and Invisible Things



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In Issue 3, we introduced fermentation, and now, in our fourth issue, we're diving into the world of microorganisms, the powerhouse behind fermentation. Kohei Ito, an entrepreneur and the face behind BIOTA Inc., believes that microorganisms are as essential as electricity, water, gas, trains, and roads in supporting our daily lives.

Kohei aims to design cities where people can live healthy and secure lives by enhancing microbial diversity in urban landscapes and architecture.

Though invisible to the naked eye, microorganisms are everywhere—on our hands and throughout our bustling cities. While they can sometimes be harmful, they are vital to our existence.

Let's explore the fascinating world of microorganisms from Kohei Ito's perspective.



Cities for Humans and Intestines for Bacteria Share Similarities

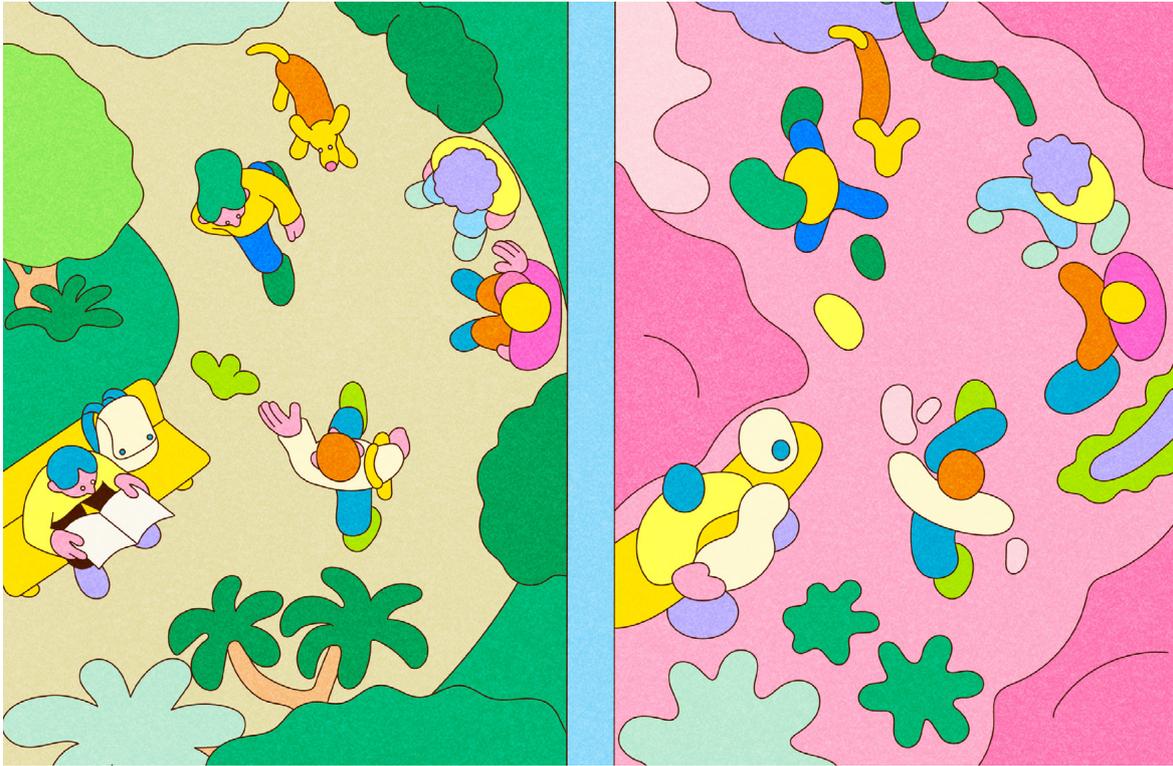
— **In your research, you investigate and analyze microorganisms in cities. What kinds of microorganisms are found in the cities where we live?**

Ito For example, train straps are covered with microorganisms commonly found on people's hands, while toilets harbor bacteria typically found in people's intestines. The microorganisms in a city are basically determined by human activities in that place. The same species of microorganisms found in deserts are also found in boilers used for hot water and heating in apartment buildings, hospitals, and office buildings because they can withstand the heat and survive there. Similarly, sewers host microorganisms that can adapt to the various chemicals flowing through them. Human behavior significantly impacts various living things in unseen places.

— **What specific microorganisms are found in the places you mentioned?**

Ito On human hands, you might find *Staphylococcus aureus* and *Propionibacterium acnes*, while *Escherichia coli* is a typical example of intestinal bacteria. However, rather than focusing on individual microorganisms, it's essential to view them as a network. For instance, the intestines contain 500 to 1,000 species of microorganisms, and understanding their interactions is crucial.

Humans behave and make decisions differently when alone versus in a group. Each person has limited abilities individually, but when people come together and interact, they can achieve much more. Similarly, cities for humans and intestines for bacteria can be seen as the same "living space"—the structure is the same, only the scale is different.



— So the same dynamics occur in the microbial world as in our society. We should probably say that our society is similar to the world of microorganisms, which has existed far longer than humans have.

Ito The microbial world has a much more diverse society than ours. New species are emerging rapidly, likely faster than our research can keep up. Therefore, the approach of “we don’t know what they are, so let’s sterilize and disinfect them” is reaching its limit.

We need to accept that we don’t know everything and find ways to coexist with microorganisms. We should embrace this kind of tolerance. After all, there are about 38 trillion microorganisms in the human body—they are “with us at this very moment.”



Developing a Sensitive and Caring Touch with Nature

— Since the COVID-19 pandemic, there has been a heightened emphasis on sterilization and disinfection. However, it’s crucial to consider creating environments where people and microorganisms can coexist rather than simply eliminating them. Am I getting it right?

Ito Continued excessive and inappropriate sterilization and disinfection can lead to the rise of drug-resistant bacteria. This occurs when microorganisms develop resistance to antibiotics used for treating diseases and to antibacterial chemicals found in paints, toothpaste, detergents, and other products through mutations. Such environments may increase the risk of contracting

infectious and other diseases.

The primary source of microorganisms in cities is believed to be humans, with individuals releasing approximately 1 million microorganisms per hour. This means densely populated areas have significantly higher microorganism concentrations, which is why infectious diseases spread easily in crowded and public spaces.

It's essential to distinguish between human-origin and naturally occurring microorganisms. Each type has its own ecological niche—microorganisms transferred to humans typically originate from the human body and cannot survive in natural environments like soil.

As cities grow increasingly crowded, the number of human-derived microorganisms is believed to have surged to excessive levels. However, reducing the overall microorganism count is challenging as urban populations expand. In response, creating a competitive environment for human-derived microorganisms is crucial. This involves boosting the presence of naturally occurring microorganisms in cities, such as those found in soil and plants. This approach aims to enhance microbial diversity through urban development practices.



— **What is interesting about studying microorganisms in cities compared to natural environments?**

Ito

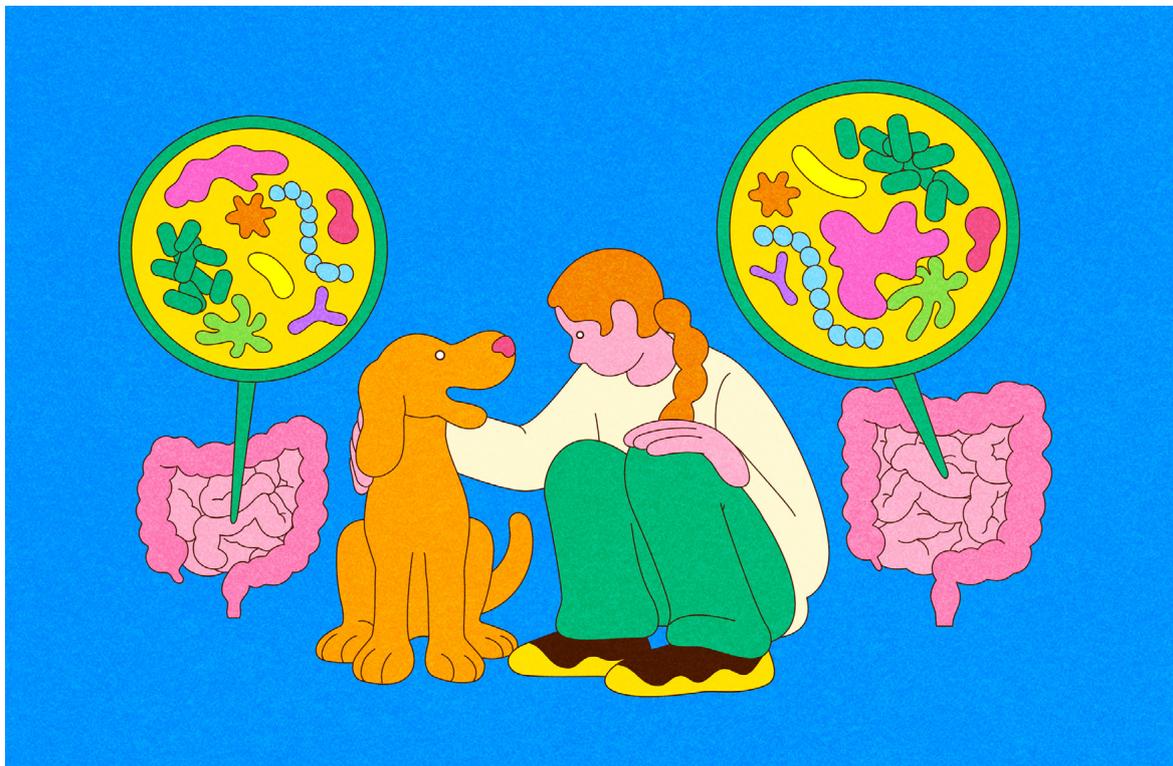
There may be a perception that human activities like constructing buildings and cities negatively impact the local ecosystem. However, I believe that human intervention in nature isn't inherently bad, as long as it's done with sensitivity and care. Of course, I'm against clearing forests without regard

for the creatures living there, but building construction can potentially create new habitats for various living organisms.

— **Can human intervention sometimes enhance the ecosystem, like how pickles become tastier when stirred?**

Ito Yes, it seems the taste of pickles changes because the microorganisms on the pickles vary depending on the person's hands who stirs them. Conversely, people also acquire microorganisms from the nukadoko (pickling bed). This interaction with microorganisms is a theme we're particularly interested in.

I've also published a preprint of a paper stating that people and dogs living together develop similar intestinal bacteria. The same goes for couples and families who live together. We know that intestinal bacteria influence emotions, and more than half of brain transmitters, such as serotonin and dopamine, are produced by intestinal bacteria. It's not surprising that similar intestinal bacteria can lead to similar sensations and emotions. I believe a kind of bond is created through microorganisms.



Microorganisms as the Infrastructure of a City

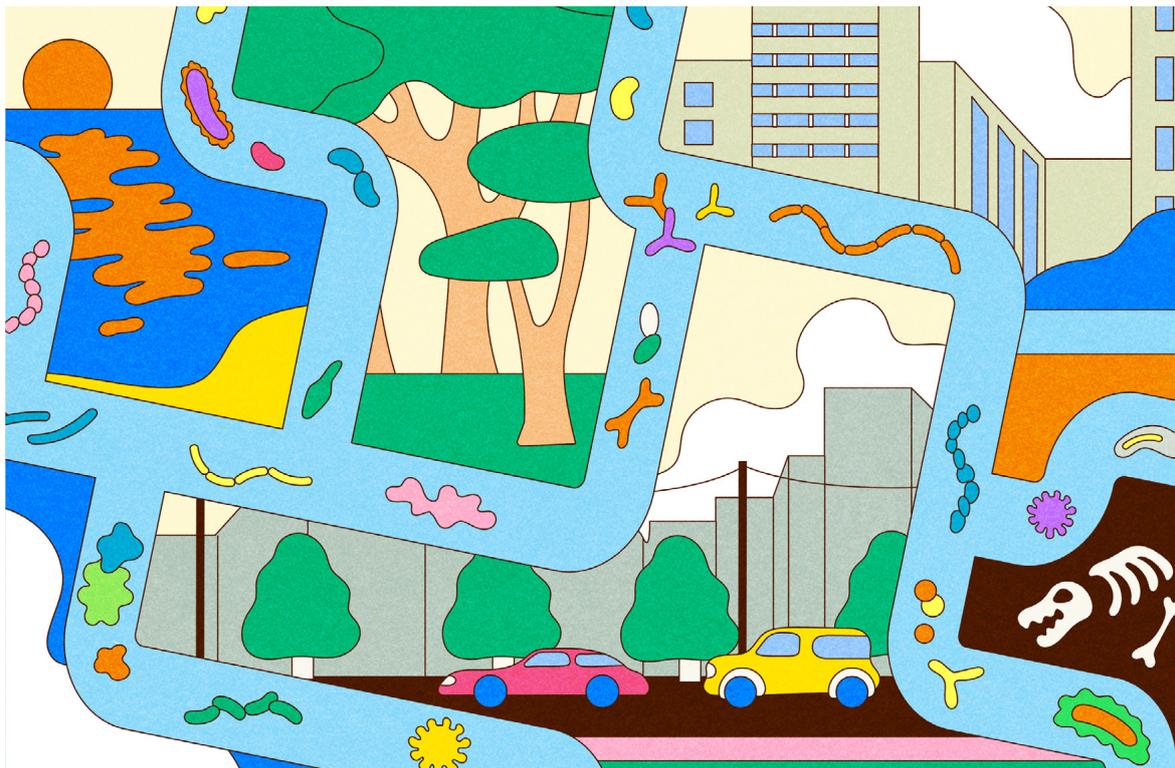
— I was impressed by "GreenAir," the microbial diffuser you developed to increase microbial diversity.

Ito The goal of GreenAir is to create a kind of “yogurt” for cities. Just as people consume yogurt to introduce beneficial bacteria into their bodies for better health, I thought we could create something to add microorganisms to urban environments. However, GreenAir is only effective in the short term, spanning 10 to 20 years. Ultimately, I want to create a world where GreenAir isn’t necessary. My goal is to establish a state where cities have inherent microbial diversity without the need to consciously add bacteria, which is why I focus on landscape and architectural design.

I believe that microorganisms are the infrastructure of a city. They may not be visible on the surface, but they play a crucial behind-the-scenes role that we couldn’t do without.

— **Is your collaboration in the “Microbes actually are all around” exhibition at the Miraikan part of your efforts to raise awareness about the microorganisms that support us?**

Ito Yes, our approach involves two main axes: science, which explores and solves problems through reason, and art, which explores and asks questions through sensibility. I believe it’s necessary not only to find solutions but also to pose questions about future challenges. That’s why we collaborate not only with researchers but also with artists and chefs.



●●●

Cycle Means to Engage with Diverse Living Things and Resources

— What kind of perspective is needed for us to recognize the presence of microorganisms in our daily lives?

Ito We humans are now able to recognize the existence of microorganisms due to advances in microscopy, genome analysis, and other technologies. However, this doesn't necessarily mean we can truly perceive microorganisms with a true sense of reality.

No matter how much progress humanity makes, we will never be able to see microorganisms with the naked eye. That's why it's important to be aware of their activities, even when they are invisible.

For example, if the area where hot spring water flows changes color to yellow or green, it indicates that microorganisms have oxidized or reduced sulfur there. Similarly, food scraps disappearing quickly in compost or bubbles forming in yeast starter for sake are signs of microbial activity. Even though we can't see the microorganisms themselves, they are engaging in a kind of dialogue. There are plenty of opportunities to notice these interactions in our daily lives.



— I would like to develop the sensitivity to sense microorganisms even if I can't see them. Finally, could you please share your approach to fostering a sustainable relationship with microorganisms?

Ito Earth is home to not only microorganisms but also various other living things. Since we share this planet, I want to explore ways for humans to better engage with other living creatures.

As I mentioned in the first issue of Monthly JP pavilion, I believe it's crucial to improve our understanding of waste disposal to achieve a true cycle. Instead of refraining from using something, we should focus on disposing of it in a way that it can be returned to other living things. With this mindset, I believe that one day, until the end of the earth's life, humans can enjoy being an irreplaceable part of the ecosystem.

Thinking about cycles and sustainability means engaging with the earth's diverse living creatures and abundant resources.



Illustration: Ayumi Takahashi

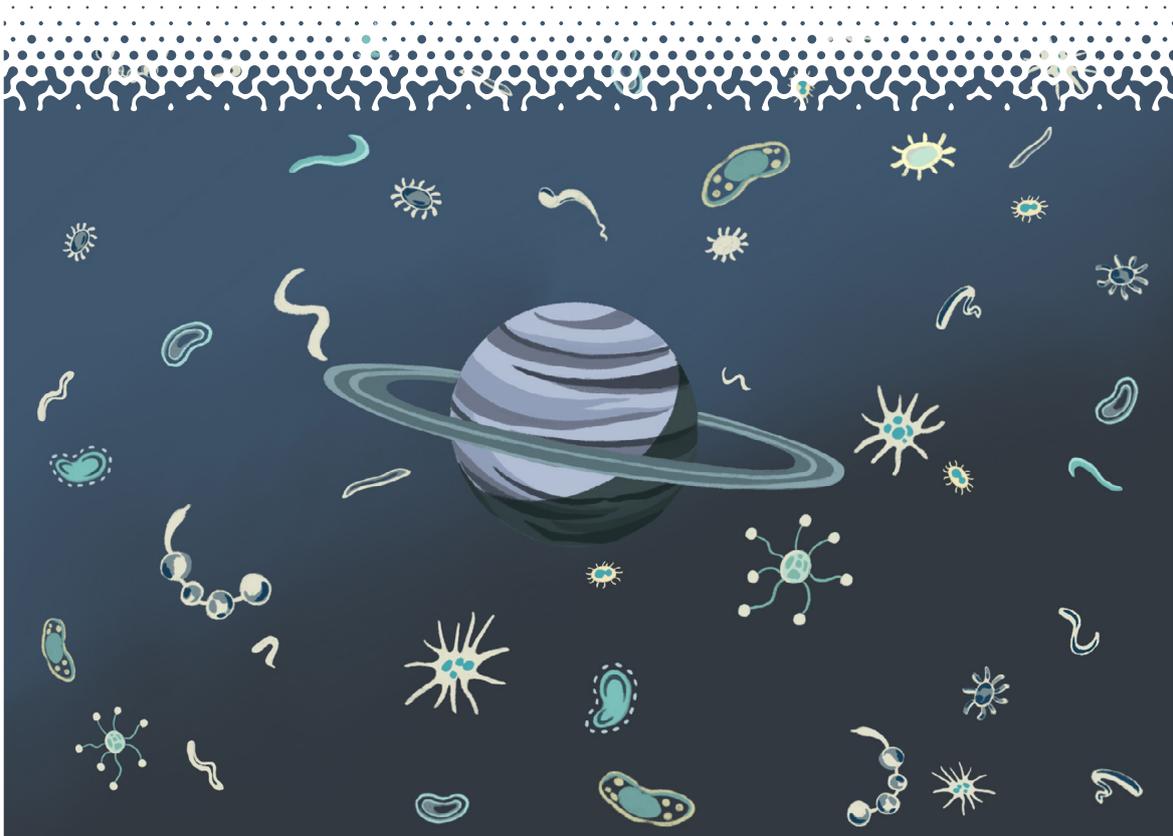


Representative Director of BIOTA Inc.,

Kohei Ito

Kohei graduated from the Faculty of Environment and Information Studies at Keio University. He has been involved in genome analysis of normal microbiota since his high school days as a special research student at the Institute for Advanced Biosciences, Keio University. During his undergraduate years, he focused on metagenome analysis of microbial communities in various environments. After completing his studies, he founded BIOTA, Inc. and has since been leading urban design projects aimed at enhancing microbial diversity.

Did Microorganisms Come from Space? Thinking about the Cosmic Scale of Cycles



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How did life on Earth originate, and how has it continued to the present day? Interestingly, the core debate surrounding the origins of life has not yet been fully resolved scientifically. Did life arise spontaneously on Earth? Or was some “seed” of life brought from outside the Earth? Recently, a field of study called “astrobiology” has been gaining attention. By closely examining the composition of other planets, their moons, and asteroids in outer space, scientists are seeking to uncover the origins of life. This connection between “space exploration” and “biology” aims to pioneer new frontiers of knowledge.

Have you heard of Japan’s asteroid exploration missions, Hayabusa and Hayabusa2? The asteroid sand samples these probes brought back to Earth might lead to groundbreaking discoveries that could help unravel the mysteries of the origin of life on our planet. One of the primary goals of space missions led by NASA and the European Space Agency (ESA) is also to uncover the origins of life.

In the last two issues of Monthly JP pavilion, we discussed microorganisms on Earth. This time, we’re shifting our focus to space. Our theme is space and microorganisms. We interviewed Dr. Akihiko Yamagishi, who belongs to the society of astrobiology—dedicated to the comprehensive study of the universe and life—to explore this fascinating topic.



How Do Microorganisms Survive in Extreme Environments?

Dr. Akihiko Yamagishi, a scientist at Tokyo University of Pharmacy and Life Sciences, specializes in extremophiles—organisms that live in extreme environments—and conducts research on space and life. We asked him the pressing question that came to mind when we read the news mentioned earlier: How can microorganisms survive in space?

“The mechanism is simple. Microorganisms can’t survive in space on their own, but by clustering together, they can protect their inner parts by sacrificing their outer layers. It’s often said that organisms die in space due to intense radiation, but that’s not entirely true. The real threat is ultraviolet (UV) radiation. So, the outer layer absorbs the UV rays. Alternatively, if they are hidden inside a hard material like a stone, the microorganisms inside can survive for about a year.”



Microorganisms and the Possibilities for the Origin of Life

If organisms can survive in outer space, it seems plausible to consider that life on Earth may have originated from space. This idea, which assumes that the “seeds of life (spermia)” are “universally (pan)” present, is known as the “panspermia theory.”

On the other hand, there is also a theory that life originated on Earth. One prominent hypothesis is the “hydrothermal vent theory,” which suggests that life’s essential materials were generated through chemical synthesis near deep-sea hydrothermal vents where high-temperature water is emitted.

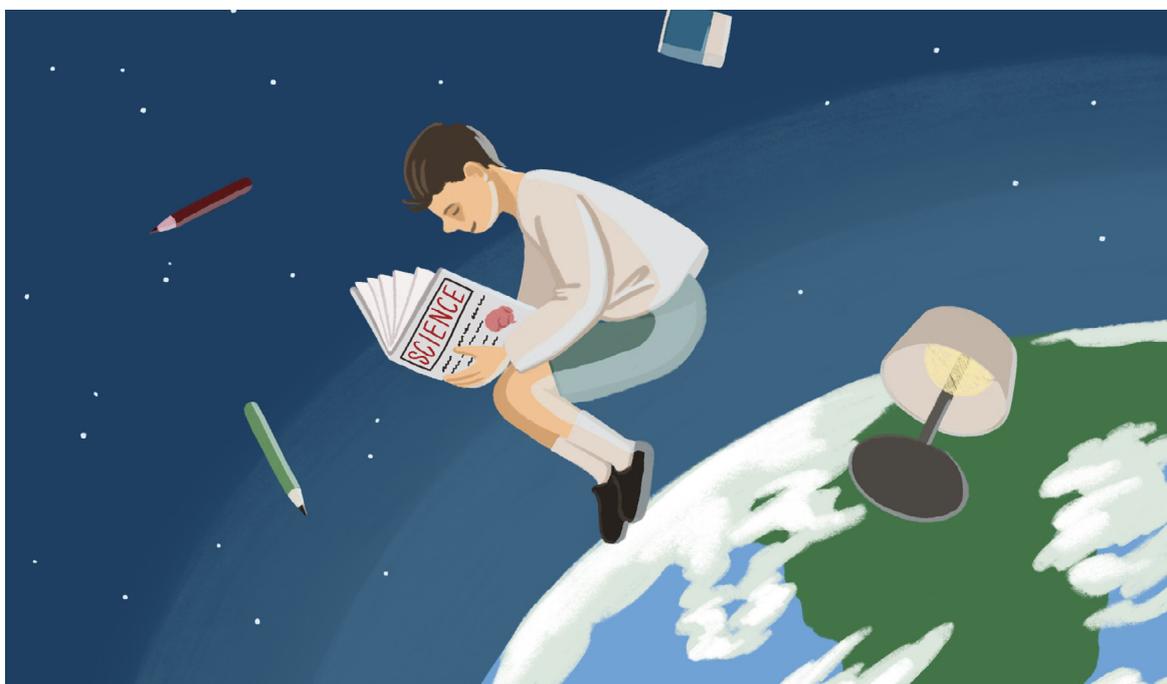
Did life emerge from Earth’s oceans? Or was it brought from outer space? It is a truly fas-

cinating debate. Dr. Akihiko Yamagishi, however, is skeptical of both theories.

“First, about panspermia. In my view, it simply suggests that life could have originated elsewhere and then traveled through space. But what I really want to know is how life came into existence in the first place. So, panspermia doesn’t truly address the origin of life. As for the hydrothermal vent hypothesis, life always contains nucleic acids, and the process of forming ribose, a key component, requires drying or the presence of land. Given this, it’s hard to argue that life originated in the sea.”

The story behind the origin of life varies among researchers, with experts from various fields proposing different theories from different angles. We also asked Dr. Yamagishi about his stance.

“I would have to say that we don’t know yet. Considering the conditions necessary for life, such as amino acids, energy, and dryness, I think the most likely location might be around hot springs in volcanic regions. But I don’t want to make any assumptions just yet. I once made a premature conclusion in another study and realized how dangerous it is to be obsessed with ‘knowing.’”



Exploring Life's Diversity

Even in this age of technological advancement, life and the universe remain enigmatic, making it a field filled with romance. Yet, it's human nature to seek definitive answers swiftly. The allure of proposing hypotheses can be captivating, drawing many, but it also risks closing minds to other possibilities.

Dr. Yamagishi finds it intriguing to consider a scenario where microorganisms did not travel through space.

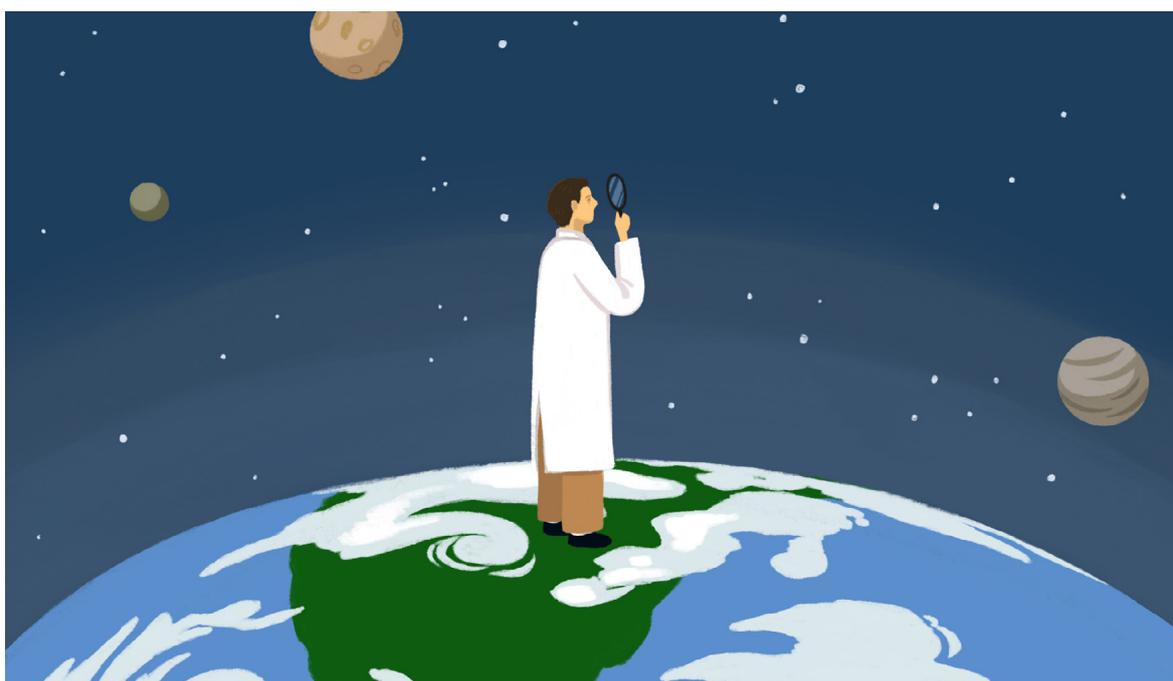
“I find it fascinating if microorganisms didn’t travel through space because it would imply independent life on each planet, fostering greater diversity. That’s what I meant by ‘intriguing.’ If it’s proven that various life forms evolved independently, studying their commonalities—such as the presence of 20 amino acids or nucleic acids—can elucidate the universal conditions for life. By comparing these conditions with their environments, we can determine the limits of where life can exist.”

The more samples of life we study, the better we can understand its origins. However, the possibility of microorganisms traveling through space suggests that the origins of life and the diversity of our samples may be more interconnected than we realize, potentially reducing our study to just one sample. This might seem like we’re straying from finding definitive answers, but science is about systematically eliminating possibilities.

Let’s dive into Dr. Yamagishi’s background. What sparked his interest in the origins of life?

“I’ve always been fascinated by the origins of the universe and life itself. That’s the only reason. Even as a child, I was captivated by Earth’s history and the evolution of life. In the science books I read back then, the entire history of the Earth was condensed into just one page, which, looking back, shows how little we knew then. But that was all we had. My interest grew more focused after returning to Japan following a postdoctoral fellowship in the U.S., when a friend shared an evolutionary phylogenetic tree published in *Science* or *Nature*. It amazed me how much we had learned about life. Looking back, I now realize the evidence seemed too tenuous to be fully credible (laughs).”

It was just before the 1980s when biology was exploring genetics. Despite Dr. Yamagishi’s interest in studying life’s evolution since the 1970s, the prevailing belief then was that life couldn’t be scientifically tested or verified. According to him, while the term “theory of evolution” existed, it was often perceived more as a concept of humanities rather than a strictly scientific one.





Launch of the Tanpopo Mission in 2007 Collecting Microorganisms in Space

It has been 50 years since then, and the world has changed dramatically. Numerous papers have been published on the origin of life, with each new hypothesis sparking intense discussions. In 2007, Dr. Yamagishi launched the Tanpopo mission to investigate the potential migration of microorganisms between planets.

“In 1986, the Soviet Union (now Russia) launched the Mir space station, and we received reports of mold growth onboard. Initially, I attributed it to human presence, but it sparked my curiosity about the possibility of microorganisms existing outside spacecraft. I was contemplating how to use airplane filters to collect and study sky dust when I saw that the Japan Aerospace Exploration Agency (JAXA) was accepting applications for airborne research projects. I applied, and our proposal was accepted, marking the beginning of the Tanpopo mission. We successfully collected *Deinococcus radiodurans*, a well-known bacterium among microbiologists.”

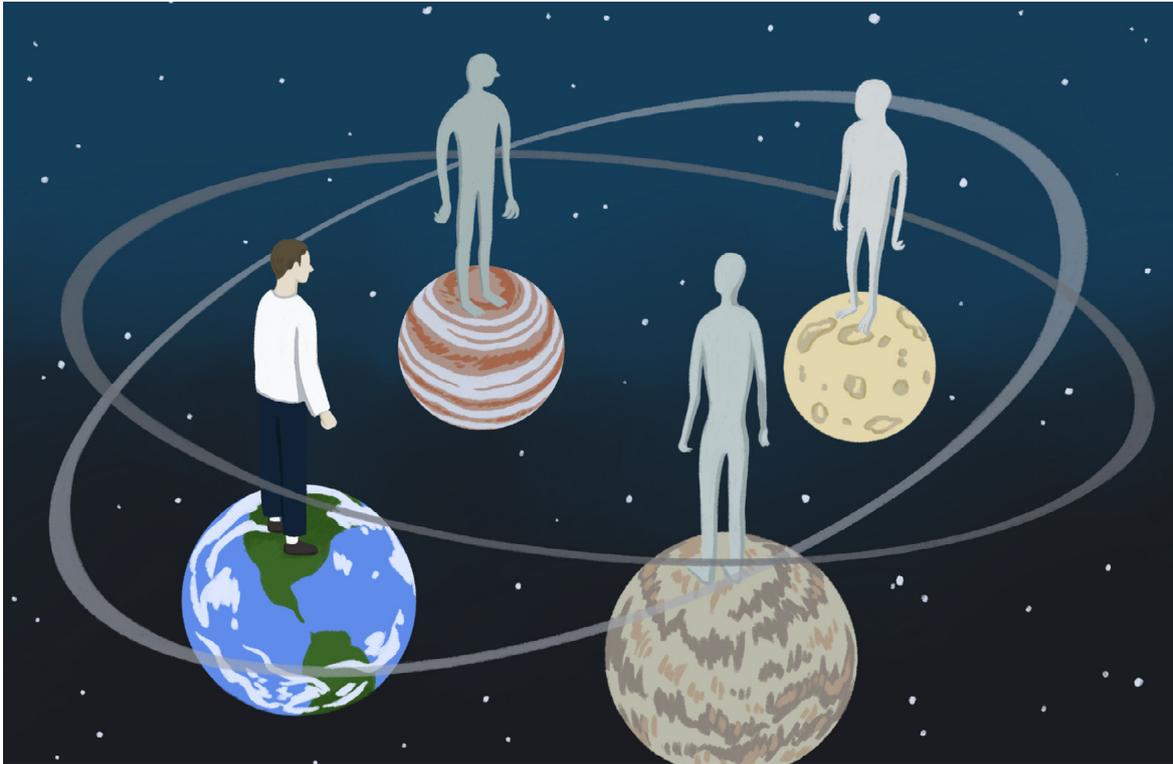
This led to further exploration. Recognizing the potential presence of more microorganisms higher in the atmosphere, the team opted to use a balloon to reach the stratosphere (10 to 50 kilometers above ground), higher than conventional aircraft could achieve. This second endeavor also yielded bacterial samples, expanding the mission’s possibilities.

While the process sounds straightforward, the actual work is exceptionally challenging. The stratosphere’s low atmospheric pressure, often one-tenth or one-hundredth that of ground level, and temperatures dropping below minus tens of degrees Celsius make human access impossible. Even automated microbial collection systems must withstand near-vacuum conditions outside. Additionally, the lid must close when the sample is dropped from the sky and lands on water, all of which must be done remotely. This requires robust communication technology, antennas, and other equipment designed for extreme environments.

Considering these challenges, one might wonder about the difficulties of collecting samples in space.

“In space research, we utilize aerogel, the lightest material on Earth. Composed almost entirely of air, it resembles solidified smoke. As microorganisms enter from space, they impact Earth’s atmosphere at speeds exceeding 8 kilometers per second—over ten times faster than a bullet due to Earth’s high rotational speed. The spacecraft, flying belly-down like an airplane, uses aerogel on its backside to selectively capture incoming particles from above. Slower microorganisms from the spacecraft adhere to the aerogel’s surface upon impact, while faster ones make holes through it, allowing us to examine them methodically. Currently, our aerogel onboard already contains approximately 300 impact sites. While most are likely remnants of micrometeorites, some may harbor microorganisms.”

Dr. Yamagishi previously expressed that it would be intriguing if microorganisms did not travel through space. However, a scientist’s duty involves impartially verifying facts based on data, regardless of personal interests. The findings from the Tanpopo mission could unveil new mysteries, shaping the research agendas of future scientists.



The Big Question Can Life Exist Outside Earth?

So far, we have explored the possibility that microorganisms may travel through space. This raises an intriguing question: could life on Earth have originated on Mars? The idea of extraterrestrial life has fascinated us for decades, often depicted in movies and other fictional worlds.

"I think scholars have different hypotheses about this. For example, consider the biologist's perspective. A biologist studying the SARC gene (a cancer gene that can cause cells to become cancerous) dedicates their career to it. If the SARC gene goes slightly wrong, humans get cancer. Given this, it is miraculous that humans can live for decades and that hundreds of millions of us do. Such a miracle might not be possible on any other planet, suggesting that aliens might not exist. On the other hand, physicists and astronomers might argue, 'Why are humans special when other planets could have similar environments to Earth?' They would think humans are just another species. From this view, it would be strange if there were no life on other planets, and there might even be more advanced civilizations elsewhere. So, depending on one's research field and perspective, the possibility of extraterrestrial life could range from zero to infinite."

In other words, we still don't have a clear answer. Dr. Yamagishi, who continues his research across multiple fields in astrobiology, says, "We can't see the finish line." However, his expression and tone do not convey any sense of defeat. We are certainly learning more. The asteroid samples recovered by Japan's space probes "Hayabusa" and "Hayabusa2" may contain clues related to the origins of life. Research is advancing rapidly, constantly

updating our understanding. Still, it is too early to draw any definitive conclusions. Finally, let us return to the theme of "JUNKAN," or cycles, promoted by the Japan Pavilion. Microorganisms drifting through space to reach Earth, and those leaving Earth might create unknown life forms on other planets. This represents the grandest story of cycles.

But from Dr. Yamagishi's perspective, the word "cycle" also carries a warning.

"A cycle refers to homeostasis, meaning it does not change. This isn't something humans created; it's a natural process Earth has maintained for a long time. Earth contains many elements that return to their original states through feedback, helping to keep its temperature constant and maintain its natural environment. In other words, cycles have always existed. However, as Earth's balance is now being disrupted, maintaining our current economic activities and lifestyles isn't a 'cycle,' but rather 'inertia.' To protect Earth's cycle, we must break out of this loop of inertia and try something new."

Illustration: Natsuki Kurachi

Harnessing Methane Fermentation Power: Meet the Biogas Rangers Saving Our Planet!



Methane fermentation is a technology that breaks down organic waste into biogas, which consists of methane and carbon dioxide, along with liquid byproducts. Despite its benefits, many people find it hard to visualize how this process works. We want more people to appreciate the appeal of this technology. In this article, we've likened methane fermentation to power rangers, a concept many people can relate to, to make it more fun and accessible.

The Japan Pavilion at Expo 2025 Osaka showcases a methane fermentation system by Hitachi Zosen Corporation. This system embodies the concept of "JUNKAN," or circulation, by breaking down and reusing food scraps collected from the venue. How will methane fermentation shine at the Japan Pavilion? We'll introduce the system and the mechanisms that will be featured at the pavilion.

—
We all want to live in an earth-friendly way, but as we go about our lives, we produce waste. When we eat, we generate food waste. Today, in a corner of Japan, there's a boy who's worried about the food waste he's created.

Boy Ugh, I studied hard for the test, but I overslept and got a zero. My mom is mad at me, and the girl I like laughed at me. I ate and drank out of frustration, and now all that's left is a pile of food waste.

All I do is add to the garbage. I feel like a burden on the planet. What can I do...?

Trio It's okay! We're here to help!

Boy Wh-Who are you?!

Hydrolysis I'm the Hydrolysis Process!

Acetogenesis I'm the Acetogenesis Process!

Methane And I'm the Methanogenic Process!

Trio Together, we are the Biogas Rangers, the Methane Fermentation Squad! We use the power of microorganisms to transform organic waste back into valuable resources, keeping the ecological cycle going!



Biogas Rangers, Methane Fermentation Squad

The heroes of methane fermentation, consisting of the Hydrolysis Process, Acetogenesis Process, and Methanogenic Process. They convert organic matter into methane gas through the power of aerobic microorganisms and methanogens.



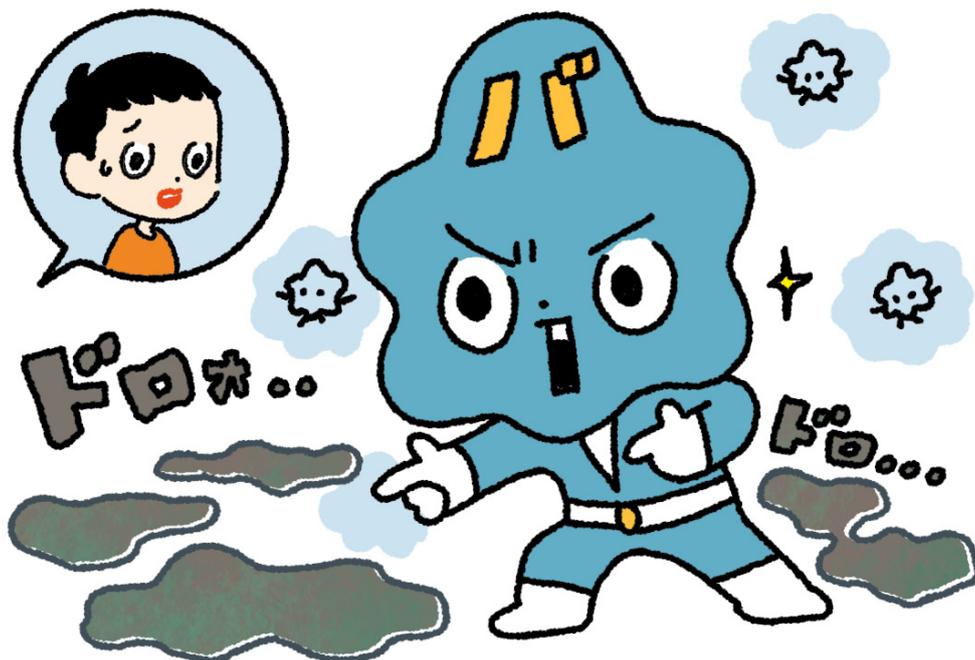
Boy

A boy who is feeling down because he hasn't had any good days lately. He lives by producing food waste every day.

Methane That biomass you have...

Boy You mean this food waste?

Methane Yes, it's wrong to treat it as mere "food waste." It is organic matter that was once part of living organisms. It's a resource waiting to be transformed. Our mission is to return what you call "food waste" back to nature with the help of microorganisms. Watch us in action!



Boy Aerobic microorganisms?

Hydrolysis Food waste contains carbohydrates, proteins, and other nutrients for microorganisms. These are dissolved into a slurry by the power of microorganisms. Let's go! Ha!

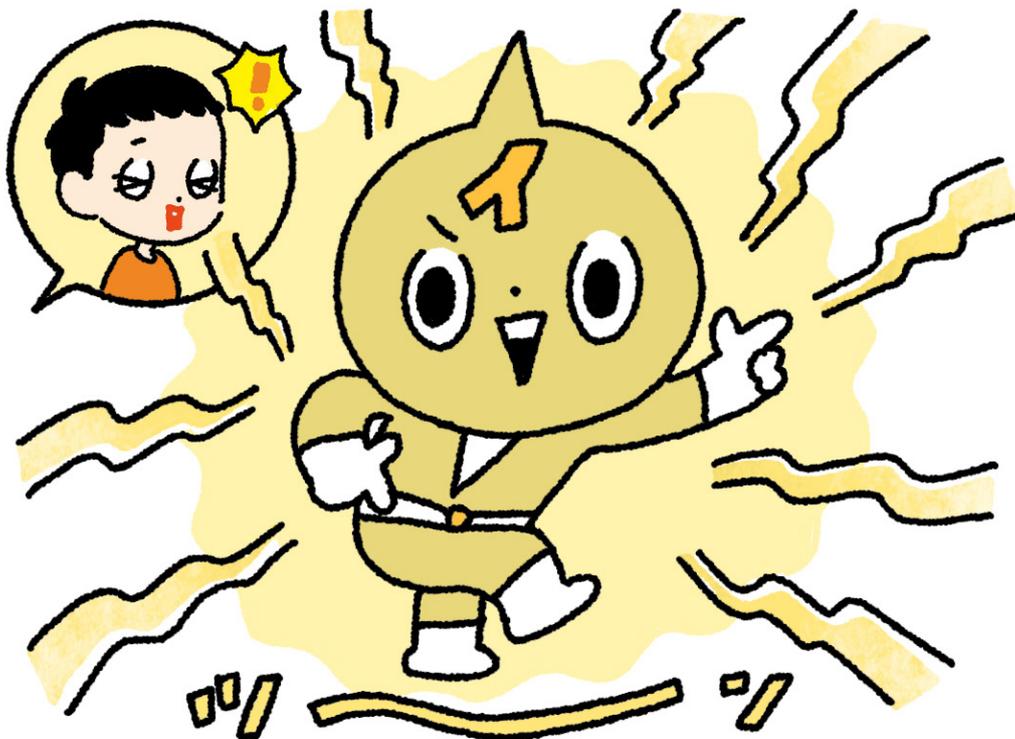
Boy Wow, the food waste is turning into mush right before my eyes! I had no idea microorganisms could do this!

Hydrolysis Imagine opening a refrigerator in an abandoned building and finding everything inside liquefied.

Boy You think I've ever seen anything like that?

Hydrolysis What was that?

Boy No, nothing. The waste is now a slurry. What happens next?



Acetogenesis Now it's my turn! The Acetogenesis Process!

Boy Acetogenesis, like vinegar?

Acetogenesis Exactly! Vinegar is mainly acetic acid. We're going to produce acetic acid and hydrogen from biomass slurry, or low-molecular-weight organic matter. Let's go, aerobic microorganisms!

Boy Aerobic microorganisms again?

Acetogenesis Not a fan?

Boy I mean...I just thought your character was similar to the other guy.

Acetogenesis It's just your preconceived notions making you think that two heroes can't have similar personalities. Let's start! Aerobic microorganisms, lend me your strength! Time for acetogenesis!

Boy Oh, that sour smell. Is this also from microorganisms?

Acetogenesis Yes, like the sour smell from leaving food waste in a trash can.

Boy What happens to this vinegar-like substance?



Methane Now, it's my turn! I am the Methanogenic Process, here to produce methane gas and carbon dioxide from acetic acid and hydrogen.

Boy But doesn't methane gas contribute to global warming through the greenhouse effect...?

Methane You're well informed! However, that's if methane is released into the atmosphere. We capture methane from food waste and use it to generate electricity. From one ton of food waste, we can produce about 100,000 1.5-liter plastic bottles worth of methane gas, where 60% is methane and the rest is carbon dioxide.

Boy But burning it produces carbon dioxide, right?

Methane The carbon dioxide released comes from plants and animals that were once part of the Earth's carbon cycle, so the overall amount on Earth doesn't increase. This is what we call carbon neutrality.

Boy I've heard of carbon neutrality somewhere before!!

Methane And that's not all. We turn food waste into gas, burn it, and the carbon dioxide released is absorbed by plants and turned into oxygen. Even when those plants eventually wither, they become resources for other energy processes. Resources continuously cycle, returning to the beginning. This is the concept of "JUNKAN."

Boy JUNKAN... It means nothing goes to waste!

Methane Exactly! Now, let's summon the methanogens. Come forth, methanogens! Show us the power of archaea that have thrived on Earth for 3.5 billion years!

Boy Methane gas; it's like a fart, but without the bad smell!

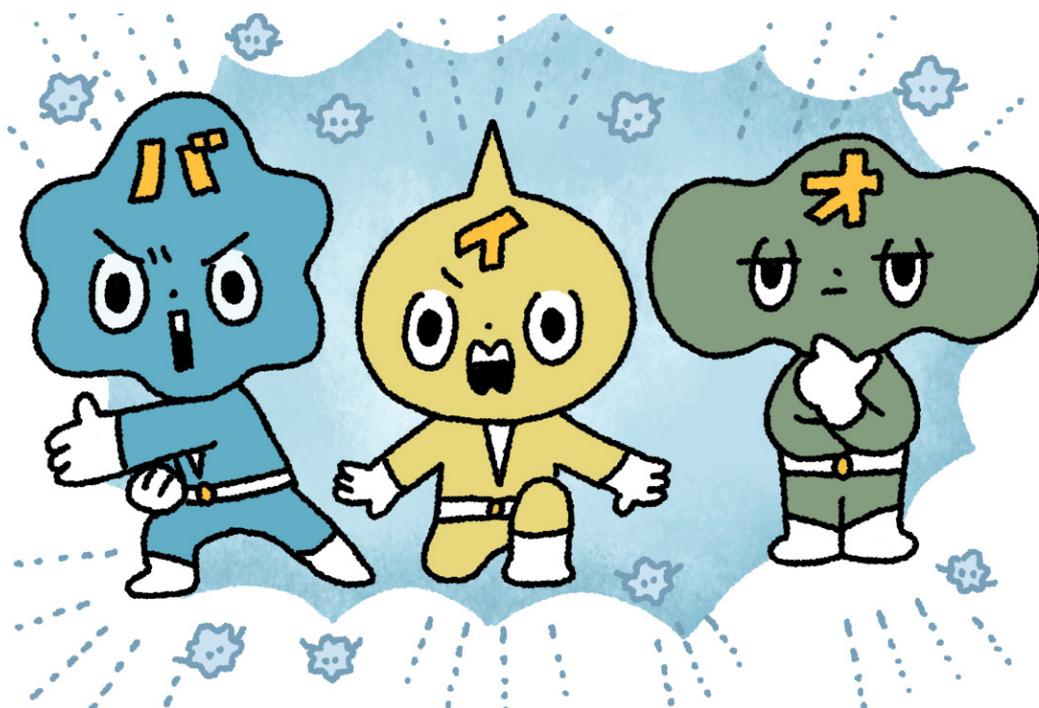
Methanogens are ancient bacteria that existed on Earth long before oxygen was abundant. They thrive in anaerobic conditions, like fermentation in enclosed spaces.

Boy So this is the power of methane!

Methane Think of it like the bubbles you see rising from a decaying fish at the bottom of a pond—that's methane gas.

Boy Could you come up with less...graphic analogies?

Methane The remaining liquid is purified by microorganisms and filtered to produce water. It's a complete circular cycle!



- Boy** Thanks for cleaning up all that food waste!
- Methane** If you're thankful, give credit to the methanogens and microorganisms. Methanogens are distant relatives, sharing a common ancestor with us billions of years ago. That ancestor branched into archaea, like methanogens, bacteria including cyanobacteria, and eventually eukaryotes, which include plants, animals, and us.
- Boy** Now I don't have to burden the Earth anymore. I just need to focus on getting a good score on my next test.
- Methane** Take your methanogens to school! With their 3.5 billion years of experience, you will be popular in school
- Boy** Um, maybe not.

▼ **Biogas Plant at Japan Pavilion, Expo 2025 Osaka**

The Japan Pavilion at Expo 2025 Osaka will showcase a biogas plant developed by Hitachi Zosen Corporation. This cutting-edge facility will refine and utilize biogas derived from biomass (such as food waste and organic matter) through methane fermentation, establishing a sustainable "JUNKAN," or cycle, within the pavilion.

Illustration: Akiko Tokunaga

Special Thanks to: Hitachi Zosen Corporation