



Finally, do you have a message for young people who may be reading this?

Whether you are getting involved in research or not, I hope you will consider how to change the system of science. As we've seen with the COVID-19 vaccine, science is incredibly important, and it can be both fun and exciting. However, in Japan, researchers often have many other responsibilities, and this has led to a decline in basic research. There are issues with the structure of society and its perception of science.

I aspire for young individuals in Japan to recognize the significance of societal support for science, akin to their American counterparts who already grasp this concept. I urge you to contemplate ways to reform our societal approach to science, explore potential solutions, and actively contribute to its betterment.

QQ I hope you understand that science is inherently something that society should support.



#### What is Bio2Q?

Bio2Q is a world-class research center at Keio University. It aims to use quantum computing and AI to analyze the interaction between Human Biology and Microbiome, revealing uncharted territories of the human body and developing new treatments for intractable diseases.

It is the first private university to be selected for the World Premier International Research Center Initiative (WPI) program promoted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT).



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WPI Research Center  
Keio University

**Bio2Q**

Human Biology  
Microbiome Quantum  
Research Center



#### Bio2Q Researchers

# Professor Kenya Honda

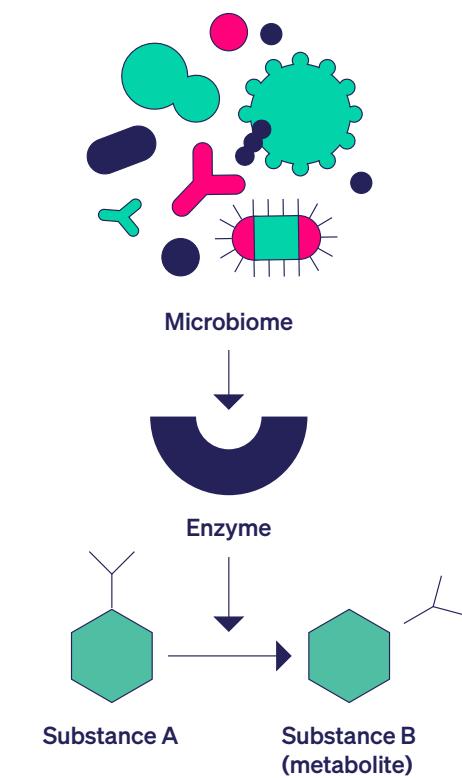
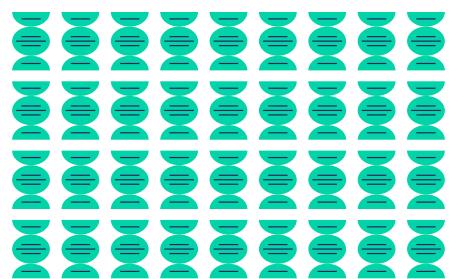
Bio2Q Director / Microbiome Team

Professor Honda serves as the head of Bio2Q and also leads his own research laboratory.

Human Genes  
27,000



Intestinal Bacteria Genes  
1,000,000



## First, please tell us about the research conducted in your laboratory.

Our laboratory primarily investigates gut bacteria, a complex ecosystem within the human abdomen comprising around one thousand different bacterial species. For instance, *E. coli* alone possesses approximately 5,000 genes, while the human genome contains roughly 27,000 genes. Intriguingly, these nearly invisible *E. coli* bacteria in our intestines carry about one-fifth of the genes found in humans, totaling nearly one million genes when accounting for all gut bacteria.

Considering genes as functional units, this implies that entities within our stomachs possess functions dozens of times more abundant than those in humans, upon which we depend. Hunter-gatherer societies exhibit even greater gut bacteria diversity, diminishing as communities transition to agriculture and urban living. Consequently, diseases like allergies, inflammatory bowel diseases, and colorectal cancer, previously uncommon, become more prevalent due to reduced bacterial gene richness, potentially leading to functional insufficiencies.

Human complexity mirrors the intricacy of gut bacteria, and their synergy performs intricate functions. Our research is dedicated to unraveling this complexity, understanding its role in maintaining good health, deciphering the mechanisms of these functions, and identifying disease triggers. This forms the core of our research focus.

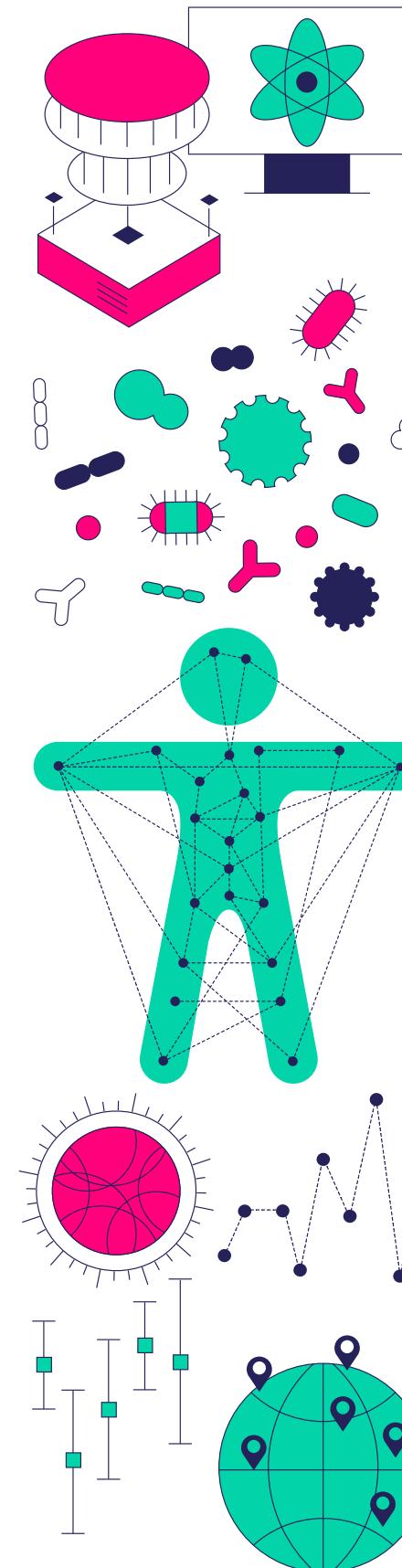


## Intestinal bacteria support human health and collectively have several orders of magnitude more genes than the human genome.

### What kind of research are you actually conducting?

The Keio University School of Medicine's Center for Supercentenarian Medical Research explores the longevity of centenarians, focusing on the role of gut bacteria in their extended lifespan. We analyze stool samples from these centenarians to uncover the secrets of their health and investigate stool samples from patients with various diseases to find new treatment approaches.

Our primary interest lies in metabolites, produced by human genes and gut bacteria via enzymes, transforming substances in the gut. With nearly one million genes in action, a multitude of metabolites are generated. Among them, human gut bacteria produce about 200,000 detectable metabolites, with over 99% remaining poorly understood. Despite our limited understanding, we depend on these substances for well-being, and their absence can lead to illness. Our research centers on uncovering these metabolites individually, forming a core aspect of our work.



## Are you examining each metabolite one by one?

We have been examining each metabolite one by one so far, but we are now collaborating with researchers in the field of quantum computing in the Faculty of Science and Technology to find out if we can understand them faster. Quantum computers are excellent at handling complex tasks. Traditional computers calculate each pattern one by one, but quantum computers can do it all at once in a single calculation. We are currently working on developing methodologies for analyzing metabolites rapidly using quantum computers.

## Where does Professor Honda's laboratory fit within the framework of Bio2Q?

It is one of the central research units. Bio2Q delves into the microbiome's vital health role, addressing its mysteries via interdisciplinary collaboration. Notably, Professor Toshiro Sato, an organoid expert, aids our exploration by using bacterial substances to stimulate human cell-cultured organoid-like structures.

Additionally, we work with Professor Michisuke Yuzaki, a neurophysiology specialist, to investigate the gut-brain connection, crucial in stress-related stomach discomfort and inflammation-induced irritability. Neurological diseases can affect the gut, and vice versa, potentially impacting conditions like Alzheimer's or Parkinson's. Professors Sato and Yuzaki, adept in their respective fields, enhance our interdisciplinary Bio2Q endeavors.

## Could you tell us about the concept of Bio2Q?

At Keio University, top scientists from various fields are currently gathering. The framework for Bio2Q seemed to naturally evolve from this environment. In a human body that is about 170 cm tall, an immense number of functions are packed. To make this possible, many different elements must be intricately intertwined. Complex interactions between organs and the microbiome are necessary for complex functions and the maintenance of health.

To understand this complexity, Bio2Q brings together researchers from various fields. I am responsible for studying gut bacteria, while there are others who focus on the nervous system, the liver, or the intestines. By conducting joint research and sharing our expertise, we may be able to solve problems that we couldn't if we were working separately.

Furthermore, we emphasize increasing the internationalization of our research. We aim to collaborate with top researchers from around the world and create a globally recognized research facility for the study of humans and gut bacteria.

\*Microbiome - A collection of a vast number of bacteria living within the body.