TOYOTA KONPON RESEARCH INSTITUTE

TOYOTA KONPON RESEARCH INSTITUTE INC.

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TOYOTA KONPON RESEARCH INSTITUTE INC.

Annual Report 2022

In Memoriam

President Shoichiro Toyoda and Cluster Research

Representative Director Shoichiro Toyoda, who was deeply involved in the establishment of the Genesis Research Institute and expertly continued to lead the organization, passed away on February 14, 2023. Members of the Institute, who received this news via the internet while at work, halted whatever task they were involved in to pause and reflect .

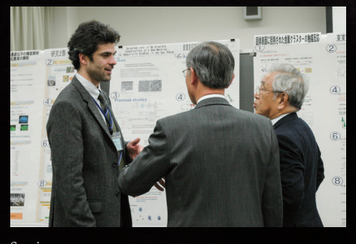
The Genesis Research Institute was established on June 11, 1996, a date commemorating the birthday of the late Kiichiro Toyoda. The Toyota group companies jointly founded the Institute with the objective of contributing to sustainable human development with a focus on the course of the necessary scientific, technological, and social research. Needless to say, both Eiji Toyoda and Shoichiro Toyoda played central roles in discussions around the Institute's establishment.

It was around that time that Professor Tamotsu Kondow and Shoichiro met, introduced by the Genesis Research Institute' s first President, Professor Toshio Sada as well as Professor Masatoshi Koshiba and Professor Kozo Kuchitsu. Professor Kondow was just starting his studies in cluster science at the University of Tokyo and completed the development of basic technologies of forming and observing clusters, putting him at the global forefront of cluster research.

A cluster is a collection of several to several thousand atoms or molecules an order of magnitude smaller than what used to be called "ultrafine particles." By manipulating the number of atoms and molecules comprising these clusters, it is possible to create new properties not found in previous materials. This was expected to lead to fundamental understanding of materials and substances, making it the main subject of research for the Genesis Research Institute.

The following year, in 1997, Professor Kondow, who had transferred to Toyota Technological Institute along with his students, was commissioned to begin basic research on cluster science. Intending to conduct frequent exchanges with researchers from around the world, he established the East Tokyo Laboratory, a small but well-equipped laboratory in Ichikawa City, Chiba Prefecture, a site that was easily accessible from Narita Airport. Professor Kondow, his students, and researchers from the Genesis Research Institute assembled here and began their research, hand-building the necessary equipment along the way. Four years later, in 2000, Professor Kondow and four young researchers were invited to present a lecture at the Nobel Symposium. Subsequently, in 2004, Professor Kondow was honored with the globally prestigious Humboldt Research Award ("Humboldt Prize"). With these and other developments, basic research was actively being conducted at the lively East Tokyo Laboratory.

Genesis Research Institute East Tokyo Laboratory Opening Ceremony



Seminar

Honorary Chairman Tours Lab

GRI2 Symposium with Professor Kondow

GRI3 Symposium Poster Session

GRI3 Symposium

Shoichiro Toyoda

Founded the Konpon Research Institute in June 1996 and directed the Institute's operations for 27 years as Representative Director.
Honorary Chairman, Toyota Motor Corporation
Doctor of Engineering (Nagoya University, 1955)
Conferred with court rank of "Junii" (Junior Second Rank), decorated with the Grand Cordon of the Order of the Paulownia Flowers, and received numerous other awards and citations.
Passed away on February 14, 2023 (age 97).

Shoichiro truly enjoyed this East Tokyo Laboratory. He often dropped by and had relaxed discussions with Professor Kondow and the young researchers there amid the lab equipment. Everyone at the East Tokyo Laboratory can recall the occasional experience of being surprised at a deeply penetrating question. Shoichiro always had a smile on his face whenever he left the laboratory. Here we present some comments from a few of those who spent valuable time with Shoichiro in the laboratory.

"I had memorable incidents in conversing about cluster research with Shoichiro. The most impressive one was when he stood in front of a molecular model. He asked us by pointing to a rod connecting some atoms, 'What is this? Are there really rods like this inside molecules? Is it really there?' I don't think I was the only one who sensed his inquisitive spirit as a scientist."
Akira Terasaki, Dean of the Faculty of Sciences, the Graduate School of Sciences, Kyushu University

"The Genesis Research Institute has provided us with ample time, space, and opportunities for cluster research. Even now, it is difficult to prepare a better research environment than this. I am again impressed by the depth of Shoichiro's passion for research."
Fumitaka Mafune, Dean of the College of Arts and Sciences and Dean of the Graduate School of Arts and Sciences, The University of Tokyo.

"Whenever Shoichiro visited our laboratory, he always created an atmosphere where we researchers could explain things without feeling timid. I am grateful to Professor Kondow and Shoichiro for fostering our development."
Jun-ya Kohno, Professor, Department of Chemistry, Faculty of Science, Gakushuin University.

"We had a plan, more like a dream, to conduct experiments together. Our great love of research was something we had in common, and we felt closer to each other."
Masahiko Ichihashi, Guest Professor, Toyota Institute of Technology.

"Shoichiro often told Professor Kondow, who really enjoys experiments, that he wanted to conduct experiments in a workman's overall. Professor Kondow planned and put on numerous individual lectures, including a lecture by Nobel Prize candidate Katsuhiko Sato, for Shoichiro who was full of curiosity. The depth of mutual understanding and trust between the two was clear."
Hisato Yasumatsu, Guest Professor, Toyota Institute of Technology

Following its establishment, the East Tokyo Laboratory became, as per the original intention, a major venue for international exchange in this subject, with dozens of groups of researchers from Japan and all over the world visiting each year, at times holding seminars, and sometimes even staying at the lab to conduct joint research. Shoichiro was extremely busy, but whenever his schedule allowed, he treasured the opportunity to participate in seminars at the East Tokyo Laboratory and encounter the world's latest research first-hand.

He particularly favored the Institute-sponsored GRI Symposium, also referred to as the "Solvay Conference," an international conference in the cluster field. The symposium was held three times, and Shoichiro was regular participant from the first meeting. He never hesitated to ask questions of experts at the conference, thus conveying his unquenchable curiosity about science to the younger cohort.

To fulfill Shoichiro's expectations, the East Tokyo Laboratory contributed to the progress of basic research, discovering phenomena and elucidating their mechanisms, while disseminating information in dozens of papers and presentations annually. Meanwhile, on the application front, the lab contributed to Toyota Motor Corporation's development of exhaust gas purification catalysts. Moreover, in terms of human resource development, we believe that we've been able to fill the role Shoichiro wanted those from the East Tokyo Laboratory to play, including heading out from the lab to serve as faculty at universities such as the University of Tokyo and Kyushu University, and helping our students from affiliated universities get launched in society.

Following these contributions both within and outside the Toyota Group, cluster science research came to an end in March 2023, as did the role played by the East Tokyo Laboratory. Cognizant of how science and technology have progressed more deeply and widely than could have been imagined at our founding, the Konpon Research Institute will use this opportunity to take up a new system and approach and further accelerate that progress, so that we may continue to contribute to the sustainable development of humankind. Shoichiro, who concentrated his vast energies on the Konpon Research Institute since its establishment, seems to be quietly and passionately appealing to us. Never forgetting Shoichiro's aim in establishing his beloved Konpon Research Institute, nor the attitude towards research that he demonstrated throughout the years after that, we are determined to carry on with research activities as we pray sincerely for the repose of his soul.

Jun Hasegawa and Noboru Kikuchi

PHILOSOPHY

Toyota Konpon Research Institute,
now it's a time to change for new evolution with an eye on the next era

Genesis Research Institute, Inc. was established in 1996 on June 11, the birthday of Kiichiro Toyoda, a founder of Toyota Motor Corporation.
While once focused solely on advancing science technology and industry previously, we change our research as the fundamentals of the well-being of mankind and the sustainability of Earth for 21st century, extending our exploration beyond human species and Earth to the vast expanse of the universe.
To mark this new beginning of our , we are renaming ourselves the "TOYOTA KONPON RESEARCH INSTITUTE, INC.," adopting the globally-recognized TOYOTA name with the aim of attracting a diverse group of the world's top researchers

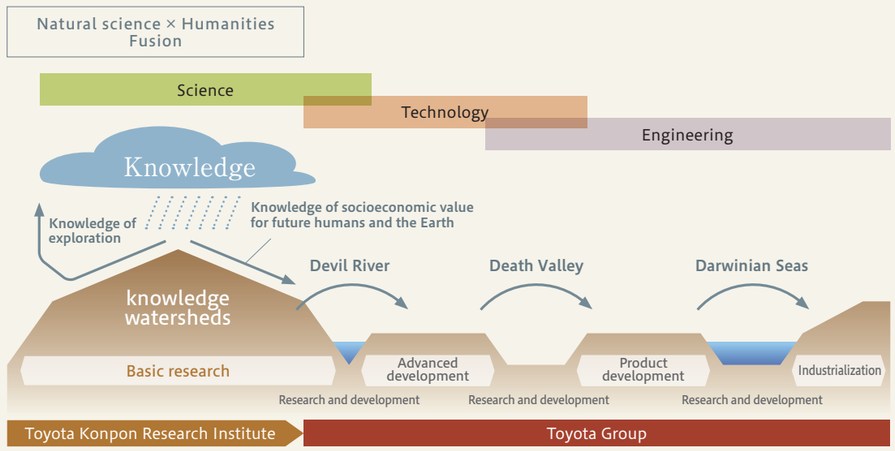
Mission | Research what to research

Inheriting our foundational ideals and actualizing our mission in alignment with the evolving times

27 years have passed since the founding of our Institute. As science and technology continue to advance, the Toyota Group's business has expanded beyond automobiles to encompass mobility, social systems, and carbon neutrality. It is essential that we adopt business practices that prioritize both humanity and the Earth. In today's rapidly changing society, our Institute's founding mission—conducting research to identify significant research themes—is gaining greater importance. To fulfil this role effectively, the Toyota Konpon Research Institute is actively pursuing a substantial evolution.

TOYOTA KONPON RESEARCH INSTITUTE

Vision | Fly over "knowledge watersheds"



Three Pillars to Realize our Vision

Explore and investigate future research themes	Increase interest in science and enhance scientific literacy	Develop human resources who can connect with diverse researchers

SPECIAL TALK

President
Noboru Kikuchi ×
Representative Director
Takeshi Uchiyamada ×
Director
Hiroyasu Watanabe

Dreams envisioned by Toyota Konpon Research Institute are focused on the future of mankind.

27 years have passed since the Institute was founded in 1996. In response to the dramatic changes taking place in the world today, Toyota Konpon Research Institute has begun to evolve its role into becoming a "knowledge watersheds."

Three top executives discuss the concept of a knowledge watersheds, as well as the future form envisioned for the Institute.

Uchiyamada Genesis Research Institute was established in 1996, right around when I was developing the Prius. The Institute was founded with the purpose of “going back to the roots of things and conducting research to identify significant research themes for the future of mankind.” Do you remember what you were doing back then?
Kikuchi I was working as a researcher at a university in the United States. I remember a conversation I had one day with Tokuta Inoue, who was instrumental in starting up the Genesis Research Institute and later became its President. He told me that they would work for something related to social systems. Then he also continued they would go back to the Edo Period, which had a circular economy, to think about recycling. I was surprised that people at Toyota thought that way.
Watanabe At that time, I was also in North America, where I had been seconded to a company as a production engineer. I remember reading an article on how Eiji Toyoda and Shoichiro Toyoda had decided to take a step forward by considering what they should do for the survival and happiness of mankind and the permanence of the Earth. This article left a strong impression on me, as did the name of the Genesis Research Institute.
Uachiyamada For the future of mankind, the Institute prepared its own experiment facilities and launched research on the extremely advanced theme of “cluster science.” It used to be thought that the properties of any substance—be it hydrogen, iron, or another substance—would be the same regardless of how many atoms gathered. However, when the number of atom clusters increased, their properties do not change proportionally; instead, these properties alter as if they underwent a sudden mutation. Researchers have become eager to discern the cause of this unexpected shift and delved into the nature of clusters to uncover specific properties, thereby paving the way for expanded applications. In fact, his research is currently being applied to automotive catalysts of the Toyota Group.
Kikuchi At that time, the word “cluster” was not a common word, so focusing on clusters was a novel concept. Although more than 25 years have passed since the Institute was established, we remain true to our philosophy of not only learning new science from outside, but also using that knowledge to look toward the future and explore the genesis.

TAKESHI UCHIYAMADA

Uchiyamada Without a doubt, the time has come to reconsider what we must do to achieve this unchanging founding philosophy. In the first place, the role of the Genesis Research Institute was to communicate the meaning of conducting such research to others. Once the research was recognized worthy, the Institute entrusted the subsequent tasks to the Toyota Central R&D Labs and other Toyota Group companies and began to seek the next. However, as the level of research at the Toyota Central R&D Labs, Toyota Group companies, and universities has improved, the Institute needs to evolve its ways.
Watanabe Everyone involved discussed what actions Toyota Konpon Research Institute must take for the future and formulated the three main pillars: “explore and investigate future research themes,” “increase interest in science and enhance scientific literacy,” and “develop human resources who can connect with diverse researchers.” One of the specific measures to achieve these goals is “the creation of opportunities.” Given the modest size of our institute, it is essential to forge connections with numerous researchers to collaboratively innovate. We require many individuals to engage in our research and guarantee the implementation of results within society. As we embark on the next phase, we aim to foster opportunities for

The world’s challenges are not uniform. Therefore, it is necessary to provide opportunities for a diverse array of research fields to cooperate.

NOBORU KIKUCHI

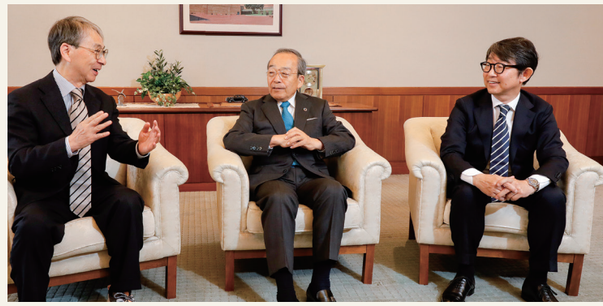
those dedicated to shaping our future society to connect through science.
Uchiyamada Creating opportunities is exactly what we need to do now. For example, as Toyota Motor Corporation has begun transforming into a “mobility company” that realizes freedom of movement for all, the group companies are also beginning to consider the entire social system of transportation and logistics. Up until now, when searching for the next research and development theme, we had thought about future needs as an extension of the past. However, going forward, it will become necessary to consider matters from the perspective of goals. We will see beyond the mountain called the “knowledge watersheds” which exists at the top of the process where science reaches social

Establishing a Toyota Konpon Research Institute Model, discovering new knowledge to connect with society

implementation. As scientists pursue the truth, we must identify research themes to be practically implemented for the benefit of society and bring those themes to this side of the mountain. Tough phases known as “Devil River,” “Death Valley” and “Darwinian Sea” will lie ahead of our research, but the drawing something from the world of science is our founding mission to “conduct research to identify significant research themes.” Creating opportunities is one important measure necessary for us to become good explorers in this way.
Kikuchi Just as dramatically different properties are suddenly exhibited when a cluster of multiple atoms gathers, “1+1” may no longer equal “2” when multiple research studies of A, B, C, etc., come together. Unlike atoms, no two researchers are the same! In a time when the world's challenges are not uniform but exceptionally diverse, I firmly believe that innovative solutions can emerge through the synthesis of diverse perspectives from various fields of wisdom.
Uchiyamada You raise a very important point. In Japan, there are many activities to deepen mutual understanding within each academic society, but overseas, there has been considerably more encouragement for researchers from diverse fields to collaborate in new research compared to Japan. We aim to develop such collaboration within our own efforts.
Kikuchi Another important point is scientific literacy. In the past, Japan was described as a “science and technology-oriented nation,” and citizens were interested in science. Nowadays, science and technology have advanced so much that people are overloaded with information. It seems that many people, except researchers, do not view things from a scientific perspective. Leading companies like TOYOTA must serve as catalysts in enhancing scientific literacy, enabling people to comprehend the utilization of scientific and technological knowledge, along with its impact on both the environment and society.
Uchiyamada That’s exactly right. Indeed, scientific literacy is one of the three pillars, and the most fundamental.

HIROYASU WATANABE

Watanabe In order to solidify these three pillars, I believe that the Toyota Konpon Research Institute must firmly connect with academia and raise the level of science.
Uchiyamada To do so, we need to improve the level of research coordinators who conduct research to identify significant research themes, thereby enabling discussions with cutting-edge researchers. For example, we have mid-level R&D personnel from the Toyota Central R&D Labs and Toyota Group companies seconded to the Toyota Konpon Research Institute. At the Institute, they work as research coordinators and gain experience in researching scientific fields while building a wide network. Upon returning to their respective companies, their experience will serve to plan and promote their research. We would like to create such a positive cycle between the Toyota Konpon Research Institute and each group company.



Kikuchi I would also like to assist researchers in academia. In Japan, there are academics doing extremely original research; for example, studying whether the dynamics of an octopus’s legs may be able to infer better answers than deep learning. However, it is difficult to translate such research into value for society, which is a great waste. Involvement by the Toyota Konpon Research Institute will be able to encourage and assist such researchers in the production and promotion to have their outstanding ideas accepted by society. It would be great if such efforts could lead to broadening the perspectives of researchers and developing research areas.
Uchiyamada As a commissioned research project, we seek to couple multiple for deepening research in a certain field or to research something completely new. From among these research themes, we will identify those which are likely to lead to social implementation and entrust those themes to other researchers. I'm very excited that, beyond the scope of business of the Toyota Group, we may identify several themes which need to be addressed in the future for the benefit of society. Although I won’t be bold enough to pronounce that we will immediately introduce our research on a global scale, I look forward to establishing a form of research known as the “Toyota Konpon Research Institute Model” in Japan and implementing that model until we receive a positive response.

Exploration Program

Developing and advancing systems to cultivate future research themes by collaborating with academia

The Toyota Konpon Research Institute takes on the challenge of establishing new systems for creating significant themes to research for the future.

Framework of research theme creation

Which mountain should I choose from the mountain range?

- Activities that look across the vast research field and discover an unexplored, cutting-edge, a nd interdisciplinary research theme
- Period: 1 year
  No. of researchers: Up to 30

Exploration ▶▶ Investigation

Are there any precious gemstones in that mountain?

- Activities to verify, evaluate, review, and determine research themes discovered through exploration
- Period: Up to 3 years
  Cost: 40 million yen/case/year
  No. of projects: Up to 6 per year

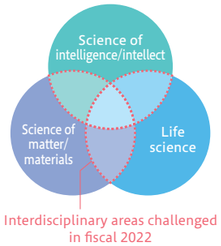
Exploring and investigating research themes require broad insight, deep expertise, and diverse perspectives. There are limits to activities that rely on the abilities of individual researchers. In exploration, we invite researchers engaged in cutting-edge research from a variety of fields. Through discussions with these researchers, we work to discover unexplored research themes from many perspectives. In investigation, we conduct commissioned research to verify the true value of themes discovered through exploration.

Exploration Program (fiscal 2022)

We invite researchers who are active in academia in a variety of fields to serve as research advisors, and conduct programs to discuss interdisciplinary themes based on cutting-edge research achievements. Research coordinators at Toyota Konpon Research Institute fulfill the role to connect research advisors.

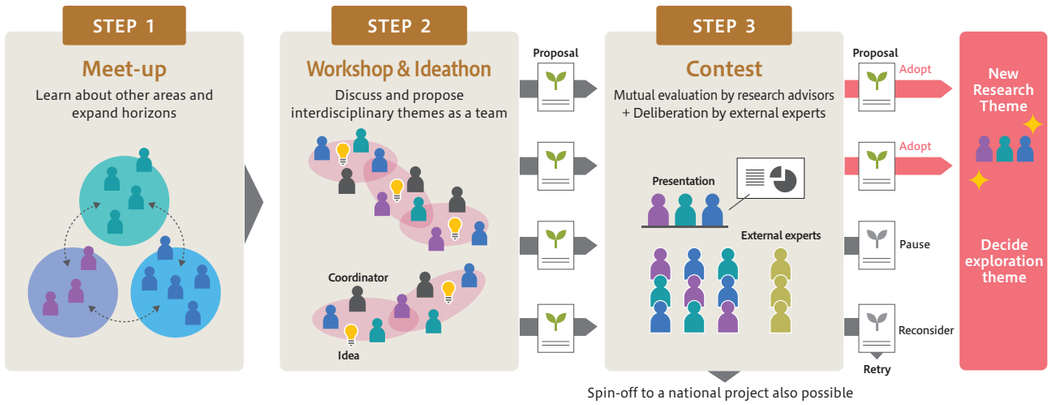
Taking up challenges and creating research themes from an unexplored interdisciplinary field that integrates three fields

A wide range of scientific fields are progressing in the academic world. Therefore, in fiscal 2022, we defined three exploration areas: 1) science of intelligence/intellect (mathematical science + information science), which is a foundation supporting other research fields, 2) life science, which provides insight into the workings of life and the natural world, and 3) science of matter/materials, which will lead to technologies that benefit society. Research advisories were selected from each scientific area in academic. Based on the results of surveys mainly from public information and recommendations from people with experience as university director posts, we have invited researchers who are expected to fulfill an active role in the future to serve as research advisors.



Steps from exploration to investigation

In order to create interdisciplinary themes by researchers from various fields, we conduct activities divided into the steps of meet-ups as an opportunity for researchers to meet and get to know each other, workshops for starting discussions, ideathons for exchanging opinions on the direction of the theme, and a contest for evaluating the appeal of research.



Yoshio Ishiguro
Associate Professor,
Interfaculty Initiative in Information Studies,
The University of Tokyo

Miho Hatanaka
Associate Professor,
Department of Chemistry,
Faculty of Science and Technology, Keio University

Kosuke Fujishima
Associate Professor,
Earth-Life Science Institute,
Tokyo Institute of Technology

Yu Kosaka
Associate Professor,
Research Center for Advanced Science and Technology,
The University of Tokyo

Tetsuya J. Kobayashi
Associate Professor,
Institute of Industrial Science, The University of Tokyo

Tomoko Isomura
Associate Professor,
Department of Cognitive and Psychological Sciences,
Graduate School of Informatics,
Nagoya University

Atsushi J Nagano
Professor,
Faculty of Agriculture,
Department of Plant Life Sciences, Ryukoku University

Ayuko Hoshino
Associate Professor,
Department of Life Science Technology,
Tokyo Institute of Technology

Naoya Takeda
Associate Professor,
School of Biological and Environmental Sciences,
Kwansei Gakuin University

Nine research advisors responded to a summons by the research coordinator

※Information on affiliation and position are provided at the time of appointment as research advisor.

STEP 1 Meet-up

An opportunity for researchers to meet, introduce themselves, introduce their current research themes, and discuss research themes they would like to try (three times in total)
The aim of the meet-up is to find seeds for new interdisciplinary research themes, using cutting-edge results (achievements) as a springboard.

STEP 2 Workshop & Ideathon

1st Workshop Toyota Commemorative Museum of Industry and Technology, Hall A (Nagoya)
The workshop was held at the Toyota Commemorative Museum of Industry and Technology, which is the birthplace of the Toyota Group. All nine research advisors participated in the workshop, which featured lively discussion based on the seeds of interdisciplinary research themes brought by each participant.

Collaboration Work On-Line
Verbalized the theme based on the Heilmeier Catechism.

Ideathon On-Line
Items requiring further clarification were identified through mutual presentation of themes and exchange of opinions.

2nd Workshop Midland Hall (Nagoya)
In preparation for the contest, participants refined the items clarified at the ideathon.

STEP 3 Contest

Contest
Entry: Submission of white paper + presentation video
Screening: Mutual evaluation by research advisors + Deliberation by external experts

Results Selected "Principles and Limits of Undiscovered Exploration" and one other theme
To start exploration research on the selected theme in fiscal 2023.

Prospects for Fiscal 2023

Expanding the exploration area

In fiscal 2022, we focused on three scientific areas. In fiscal 2023, we will add the humanities to enable comprehensive consideration, including the natural sciences and humanities. In this way, we aim to create opportunities for more comprehensive and fundamental exploration of themes.

Support for the child-rearing generation

Many of our research advisors are in the child-rearing generation. There were cases in which research advisors ended their discussion and left the workshop early in time to pick up their children from nursery school. In fiscal 2023, we will set up a temporary childcare center at the workshop venue, with the aim of creating a program where research advisors can participate together with their children.

Toyota Konpon Research Institute Lecture Series

Providing an opportunity to interact with fundamental and large-scale knowledge and to gain a higher perspective.

Toyota Konpon Research Institute plays the key role of bridging Toyota Group companies with knowledge that has the potential to create new value.
To achieve this goal, we are focusing on activities to enhance scientific literacy within the Toyota Group.
As part of these activities, we have started the Konpon Research Institute Lecture Series.

Look at the whole picture. Think in a long-term framework.

The areas covered by the lecture series are fundamental science related to "science of matter/materials", "science of intelligence/intellect" and "life science."
The content of the talks is not deep and narrow targeting a specific field; instead, they focus on looking at the whole picture and thinking over a long time frame.
Through the talks,people from Toyota Group companies are expected to gain new perspectives, to broaden horizons, and to obtain a higher viewpoint.

"Earth and Planetary Science" was selected as the first topic of the new initiative.

The first lecture series focused on "Earth and Planetary Sciences". The talks provided an opportunity for audiences to consider the fundamentals of the issues that the Toyota Group is currently facing; specifically, carbon neutrality, Earth resources, and extreme materials design under extreme conditions.

Speaker

Professor Kei Hirose
(Specialty: High Pressure Earth Science)

Department of Earth and Planetary Science,
Graduate School of Science,
The University of Tokyo

The First Director of the Earth-Life Science Institute of Tokyo Institute of Technology, one of the World Premier International Research Center Initiative (WPI)

Authored by Kei Hirose
Kodansha Publishing

Books for the general public

What is Found When Digging Deeper into the Earth?
Kawade Yume Shinsho Publishing, 2022

Contents of the Earth—What's Inside, What's Happening?
Kodansha Bluebacks Publishing, 2022

The Brand New Earth: Conditions for the Birth of Life
Iwanami Science Library, 2015

Report on Activities in Fiscal 2022

Insight From the Earth | Where Do We Come From? Where Are We Going?

Conducted via a hybrid method of on-site + on-line

Day 1 Plate Tectonics and Material Circulation Within the Earth

Tuesday, August 30
At Toyota Commemorative Museum of Industry and Technology,

Material circulation throughout the Earth system closely related to carbon neutrality

CO_2 was once the main component of the atmosphere. Why has the amount of CO_2 now plummeted to just 0.04%? The key to solving large changes in the atmosphere lies in plate tectonics (the theory of movement of plates covering the Earth's surface). The movement of plates not only causes earthquakes, volcanic activity, and continental growth, but also transoports materials from the Earth's surface to its depths. In this talk, Professor Hirose explained the role of plate tectonics within the Earth, and the evolution of the Earth brought about by plate movements (such as the removal of CO_2, which was the main component of the early Earth's atmosphere).

Number of registered participants: 644

〈Feedback from participants〉

- The fragmented knowledge about the Earth was explained in an easy-to-understand manner as part of the overall system.
- I was surprised to learn that plate tectonics is related to the fixation of CO_2.

Day 2 Earth's Iron and Core

Wednesday, October 12
At Toyota Physical and Chemical Research Institute(co-hosted by TPCRI)

Distribution and origin of Earth resources, and creation of materials under ultra-high pressure

Now that scientists have acquired the technology to design a variety of materials,can we say that we understand the complete picture of materials? For example, consider iron, which is one of the Earth's major elements after oxygen, magnesium, and silicon. Where does iron exist on the Earth and in what form? Also, what role did the photosynthesis by living organisms play in the formation of iron ore? Furthermore, what were the environmental conditions for the formation of the highly electrically and thermally conductive post-perovskite structural phase discovered in this century? In this talk, Professor Hirose explored the potential of the materials that exist on Earth.

Number of registered participants: 738

〈Feedback from participants〉

- I learned about the mechanism by which the abundance ratios of elements differ between the Earth's surface and deep underground.
- I was excited by the vast scale covered by the talk. It is an unexpected fact that leap seconds are caused by the electrically conductive crystal structure of the lowermost mantle.

Day 3 Birth and Evolution of the Earth

Wednesday, November 23
Toyota Commemorative Museum of Industry and Technology (open to the general public)

Water is the key to climate and life, and Earth's magnetic field has a major impact on communication technology.

It is said that the Earth was formed through the magma ocean formation due to giant impacts. Where does evidence of this major event remain on the Earth? Earth is known as the "water planet"—how much water does the Earth have and where is that water now? Unlike Mars, how has the Earth been able to maintain its magnetic field and oceans? In this talk, Professor Hirose introduced the latest research results to answer such questions about the Earth from the past to the present, and explained how the future Earth has the potential to evolve.

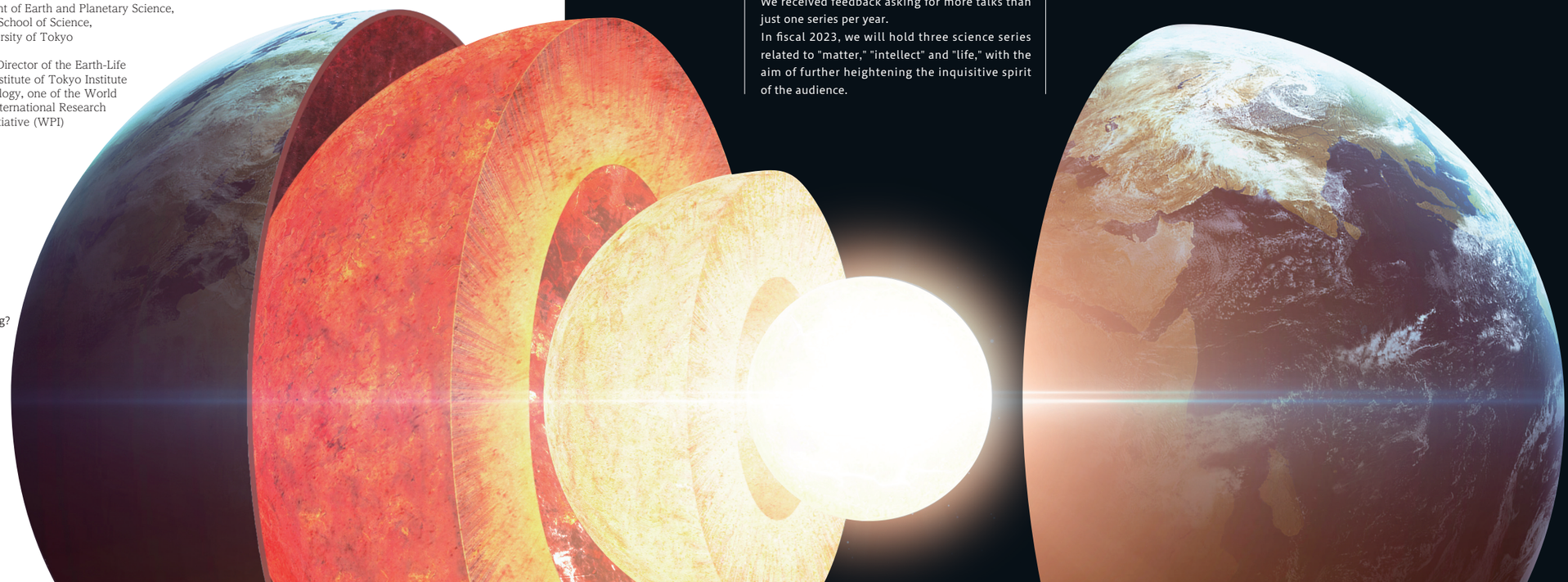
Number of registered participants: 579

〈Feedback from participants〉

- Through comparisons with Mars and Venus, I realized once again that the Earth is a rare entity and exists in an exquisite balance.
- I realized how little we actually know about the Earth beneath our feet.

Prospects for Fiscal 2023

We received feedback asking for more talks than just one series per year.
In fiscal 2023, we will hold three science series related to "matter," "intellect" and "life," with the aim of further heightening the inquisitive spirit of the audience.



Basic Research in Cluster Science

Cluster science is a new concept research field that the Genesis Research Institute decided to pursue immediately after being established.

The cluster science is the research field originating from 'molecule assemblies', which were recognized in the early 1980s as hindrances preventing experiments for molecular structures. Now called “clusters,” these molecular associations are an order of magnitude smaller than the 10 to 100 nm ultrafine particles that were being researched at the time. There have been advancements in research on cluster properties and the detection/measurement methods which form the basis for cluster science research. In the late 1990s, expectations began to grow for further elucidation of the mechanism and applications of clusters. The Genesis Research Institute was established around the same time with the aim of “conducting research to identify significant research themes.” For the Institute, cluster science was the perfect field to begin with. Professor Tamotsu Kondow, a distinguished expert who laid the groundwork for cluster science research in Japan, has been appointed to the Toyota Technological Institute. Concurrently, we have inaugurated the East Tokyo Laboratory, amalgamating it with the Cluster Research Laboratory at the Toyota Technological Institute, to commence our research endeavors.

Research results that contributed to both academia and industrial applications

Cluster research has continued for 26 years from 1997 to 2022. We have achieved many results through our approach from both the academic side, which examines the essence of phenomena, and the application side, which helps society and industry.

Academic results (by those who enrolled from AY1997 to AY2022)

Papers and reviews: 395

Awards: 7

Presentations at academic conferences: 1000

- Presentations at international conferences: 382
- Presentations at international academic conferences: 595
- Academic conference sponsorships/planning projects: 23
- Overseas visitors: 213
- Domestic visitors: 374
- Overseas seminars: 47
- Domestic seminars: 84

Patents: 28

Books: 8

1. Encyclopedia of Physics Editing Committee, Chairman Jiro Maki, Maruzen Publishing
2. The Chemical Society of Japan, Maruzen Publishing
3. Practical Dictionary of Catalysts Editing Committee / Editor, Kogyo Chosakai Publishing
4. Co-authored by Tamotsu Kondo and Masahiko Ichihashi, SHOKABO
5. Co-authored by Tamotsu Kondo and Fumitaka Mafune, SHOKABO
6. Authored by Tatsuya Tsukuda, Science-Sha
7. Edited by Tamotsu Kondo, authored by Masahiro Kotani, Seiichiro Koda, and Kiyohiko Someda, Tokyo Kagaku Dozin
8. Edited by Akira Sugano, Tamotsu Kondo, and Koji Kaya, Kodansha Scientific

Results of industrial application

In 2002, we launched an automobile catalyst cluster research project with the Advanced Material Engineering Division of Toyota Motor Corporation. We clarified the effect of cluster size (number of atoms) on catalyst performance. Exhaust gas catalysts that use these research results have been installed in vehicles since 2014 This has significantly reduced the proportion of precious metals used in catalysts. Furthermore, in June 2020, we transferred the technology for cluster catalysts fixed in zeolite pores.

A bridge to the future

The achievements of the Konpon Research Institute include the production of highly-skilled human resources. Researchers who worked at the East Tokyo Laboratory are currently leading research in the field of cluster science in terms of both academia and industrial application at research institutes in Japan’s leading universities and companies, including the University of Tokyo and Kyushu University. The Institute also fostered human resources by accepting internships and providing support for degree acquisition.

Main researchers produced by the Konpon Research Institute

- Professor Akira Terasaki, Dean of Graduate School of Science, Kyushu University
- Fumitaka Mafune, Professor, Dean of Graduate School of Arts and Sciences and College of Arts and Sciences, The University of Tokyo
- Jun-Ya Kohno, Professor, Chemistry Department, Faculty of Science, Gakushuin University

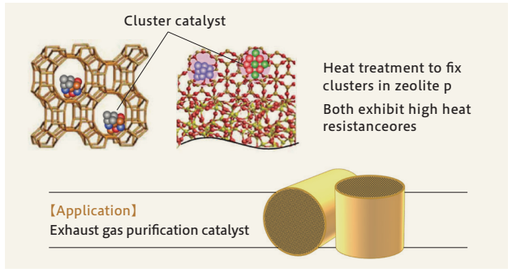
Notable results achieved by the Genesis Research Institute

Establishment of cluster fixation method on solid surfaces (applied research)

The generation and reaction of clusters in experiments is performed while clusters are floating in a vacuum, but clusters must be taken out of the vacuum for application in the real world.However, because clusters have a large surface area relative to their volume, they quickly aggregate into bulk due to how atoms and molecules tend to stabilize by reducing their surface energy. In order to prevent aggregation into bulk and maintain the size and properties of clusters, we established two methods for stabilizing clusters by supporting them on solid surfaces.

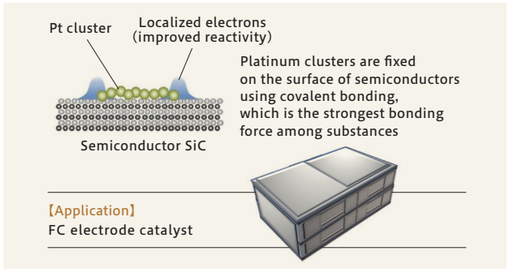
Zeolite fixed catalyst

After using the Coulomb force to electrically adhere positively-charged clusters to negatively-charged acid sites within the zeolite pores, we perform heat treatment to strengthen the bonds.We use the Coulomb force to stick positively-charged clusters to negatively-charged acid sites in zeolite pores, then heat them to strengthen the bonds.After using the Coulomb force to electrically adhere positively-charged clusters to negatively-charged acid sites within the zeolite pores, we proceed with heat treatment to fortify the bonds.



Semiconductor fixed catalyst

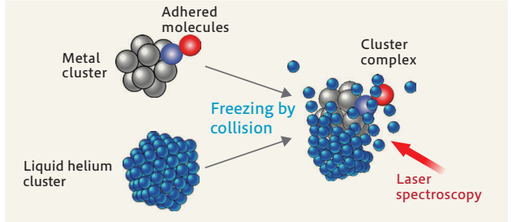
We fix clusters by utilizing the property in which silicon (Si) existing in the semiconductors materials and silicon in silicon carbide (SiC) bonds strongly with platinum (Pt).

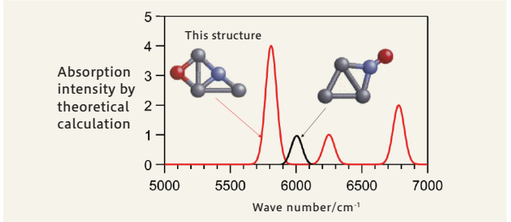


Optical observation of cluster structure during chemical reactions [basic research]

We have developed a method to analyze the structure at intermediate stages of chemical reactions in which clusters and molecules combine to form “composite clusters.” We optically observed the transition state of the reaction between cobalt clusters and nitric oxide (NO) molecules. In the analysis method, we start by adhering NO molecules to metallic cobalt clusters of different sizes (different number of atoms), and then freezing the cobalt clusters by colliding them with helium clusters. Next, we irradiate the clusters with lasers of various wavelengths (energy) and experimentally measure which wavelengths of light are absorbed.

On the other hand, we use theoretical calculations in quantum chemistry to determine which structure absorbs light at which energy level. We identify the structure by comparing experimental results with theoretical calculations. Our experiments clarified that a cobalt trimer cluster consisting of three cobalt atoms changes its own structure and causes an NO adsorption reaction. By applying this observation method to understanding the intermediate states of various chemical reactions, we can expect application to catalyst design.





What is a cluster?

All matter consists of atoms. A cluster is an ultrafine particle with a diameter of 1 nm or less that is made up of several to about 1,000 atoms. Clusters exhibit physical properties that are different from those of molecules that exist stably and those that are visible in size (bulk). In particular, small clusters consisting of several atoms are characterized by rapid changes in properties, such as the presence or absence of magnetism due to a difference of just one atom.

Differences between atoms and clusters

Science based on atoms

Atom → Molecule → Solid

The periodic table serves as a design guideline.

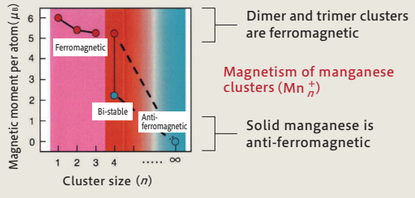
Science based on clusters

Cluster → Cluster complex

Possesses specific properties (chemical reactivity, optical properties, magnetic properties, electrical properties, thermal properties, etc.)

Discover the design guidelines.

Graph of the number of atoms and reactivity



RESEARCH FRONTLINE

01 Establish a hydroponic method to increase crop yields and discover the effectiveness of hydroponic cultivation for medicinal plants

Research on promoting plant utilization

Research period: 2012 to 2022
Principal researchers: Yasuhiko Komatsu (2012 to 2017), Masatoshi Matsuda (2012 to 2021), Masahiro Horikawa (2018 to 2020), and Satoshi Kondo (2021 to 2022)
Collaborative researchers: Kiwamu Minamisawa (Professor of Tohoku University, 2012 to 2021), Shusei Sato (Professor of Tohoku University, 2020 to 2021), Ryo Akashi (Professor, University of Miyazaki, 2012 to 2021)

Research on promoting the use of plants has focused on soybeans, which are important as food, with the aim of increasing yields and increasing food production. In order to improve yields, we conducted research on hydroponic cultivation, symbiotic bacteria (*Enterobacter*), and superroots of legumes with vigorous root growth. In hydroponic cultivation, the yield per plant was significantly improved by more than 10 times, and in symbiotic bacteria inoculation, the yield was improved by about 20%.
In 2022, we investigated the hydroponic cultivation of other plants such as medicinal plants in addition to hydroponic cultivation of soybeans. The medicinal plant that we tested was crow dipper (*Pinellia* ternata). We evaluated the weight of the underground part (rhizome) and aboveground part (propagule), and the herbal medicine component (arabinose) when using hydroponic cultivation. Hydroponic cultivation is more effective than cultivation using only water for the weight both of the underground part and above-ground part. Furthermore, in hydroponic cultivation, the effect of using hydro balls (artificial soil) and pumice as a culture medium is higher than that of soil. Preliminary calculations indicate that cultivation in a nutrient solution utilizing hydro balls yielded an underground part weight roughly 70 times greater and crude drug ingredients approximately 50 times greater compared to those obtained from soil cultivation. This indicates that hydroponic cultivation, which has been applied to soybeans, is also effective for medicinal plants.

Outreach activities

The inoculation method of symbiotic bacteria (*Enterobacter*), which was effective in improving the yield of soybean grown in soil, was introduced to the Agriculture & Biotechnology Business Division of Toyota Motor Corporation and the transfer of technology has been completed.

RESEARCH FRONTLINE

02 Clarify the interaction between light and matter

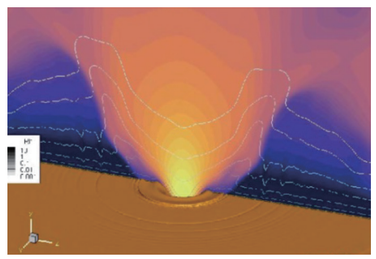
Basic research in optical science

Implementation period: Compact high-power lasers (2007 to 2021), New material creation using lasers (2014 to 2022)
Principal researcher: Tatsuo Inoue (2007 to 2022) Collaborative researcher:Compact high-power lasers
Takunori Taira (Project Professor of Institute for Molecular Science, 2007 to 2021) and Yoichi Sato (Institute for Molecular Science, 2007 to 2021)
Creation of new materials using lasers Ryosuke Kodama (Professor of Osaka University, 2014 to 2022), Norimasa Ozaki (Associate Professor of Osaka University, 2014 to 2022)

As evidenced by the fact that matter and antimatter are created when strong light shines into a vacuum, elucidating the interaction between light and matter will lead to understanding matter in this world and creating new matter. For this reason, we have researched the creation of new materials using existing light, while pursuing even stronger and higher quality light. The ability to realize strong, high-quality light (high-power lasers) depends on how efficiently the stored energy can be released. Therefore, we enclosed ytterbium, which is the most efficient element for storing and releasing energy, in a strong and transparent polycrystalline ceramic that can withstand high energy.
Furthermore, by aligning the orientation of individual crystals, we have achieved strength that is 1,000 times greater compared to existing materials, which have the world's highest strength per unit volume. On the other hand, even with existing lasers, high energy can be obtained by concentrating the power in an extremely short period of time. When such lasers hit the surface of a material, it generates ultra-high pressure equal to or even higher than the pressure inside the Earth, resulting in the reduced distance among atoms composing materials. For example, we discovered that semiconductor silicon can be turned into metallic silicon, and carbon such as graphite can be turned into diamonds.

Outreach activities

We have designed and manufactured a device capable of generating a specialized magnetic field to align polycrystalline ceramic materials, resulting in a patented technology. Additionally, we have developed a unique method for generating ultra-high pressure and measuring the microstructure of materials undergoing pressure-induced changes. Our efforts will continue to advance this technology to search themes in the field of materials science.



Simulation of metal surface deformation by laser

RESEARCH FRONTLINE

03 Elucidate the mechanisms of emotions and behavior to protect the future of the zhuman heart and humanity

Research on humans and society

Implementation period: 2015 to 2022
Principal researchers: Nobuo Okumura (2015 to 2016), Kazuhiko Yamamoto (2017 to 2022)
Collaborative researchers: Toshio Inui (Professor of Otemon Gakuin University, 2015 to 2019), Katsumi Watanabe (Professor of Waseda University, 2015 to 2022), Masamichi Sakagami (Professor of Tamagawa University, 2020 to 2022)

We have conducted multifaceted research on humans and society with the aim of always maintaining a healthy mental state and searching the direction of brain science that will be reflected in future social systems and new products including artificial intelligence. As a representative example of research conducted to date, first, we found a possibility that physiological states and visceral sensations are integrated with emotions in the insula, a part of the brain, for decision-making while clarifying the mechanism of generating emotions from both the body and the brain. Secondly, we have conducted research for creating a mathematical model based on the theory that all human behavior desires to minimize the difference between the predictions made by the brain and the representations obtained through the senses, and that this desire is combined with curiosity and reward incentives to determine behavior. Next, through our research on the impact of external opinions on human behavior, we discovered a tendency among individuals to resist conforming to the opinions of others. Nevertheless, we observed that altruistic majority opinions have the potential to influence both opinions and actions. Furthermore, our ongoing investigations have explored the human inclination towards cooperation, even at the expense of personal interests, through the two decision-making systems: inductive and deductive.

Outreach activities

For the purpose of utilizing research on humans and society, we publish materials such as scientific reports (Proselfs depend more on model-based than model-free learning in a non-social probabilistic state-transition task) and books ((1) What are Emotions in the First Place? Minerva Shobo Publishing, 2018; (2) Grand Unified Theory of the Brain, Iwanami Shoten Publishing, 2020). We passed on the knowledge gained from the research to Toyota Motor Corporation and Toyota Central R&D Labs, Inc.

Authored by Toshiro Inui
Minerva Shobo Publishing

RESEARCH FRONTLINE

04 Engaging in the pursuit of effective disaster countermeasures and unraveling precursor phenomena to facilitate earthquake prediction.

Research in disaster mitigation and Earth science

Implementation period: Disaster mitigation 2012 to 2021 and Earth science 2014 to 2022
Principal researchers: Hiroyuki Isawa (2012to2014), Nobuo Okumura (2015 to 2016), and Hitoshi Kondo (2017 to 2022)
Collaborative researchers: Nobuo Fukuwa, Professor of Nagoya University (2012 to 2021), Yoshiyuki Kaneda, Project Leader of Japan Agency for Marine-Earth Science and Technology (2012 to 2014), Yuji Enomoto, Specially Appointed Professor of Shinshu University (2015 to 2022), Toshiyasu Nagao, Professor of Tokai University (2016 to 2022), Chihiro Yamanaka, Associate Professor of Osaka University (2017 to 2022), and Hiroyuki Furukawa, Researcher of Institute for Laser Technology (2016 to 2022)

Since 2012, we have conducted research in disaster mitigation with Nagoya University and the Japan Agency for Marine-Earth Science and Technology, with the aim of estimating damage and predicting recovery in the event of a mega-earthquake in the Nankai Trough. Also, in 2014, we started research in cooperation with Shinshu University, Tokai University, Osaka University, and the Institute for Laser Technology to conduct research in Earth science to clarify earthquake mechanisms with the aim of reducing damage by conducting evacuations and shutting down equipment in advance. In disaster mitigation research, Using the Earth Simulator, we predicted the impact of significant earthquakes and validated an optimal recovery schedule through simulation. We also held *Honne no Kai* (Information Sharing Meetings), which are closed study sessions with limited members. Through privately exchanging information among meeting participants, they were able to ascertain actual damage and review disaster countermeasures. In Earth science research, we've formed an Earthquake Precursor Study Group comprising researchers irrespective of any formal joint research agreements. Together, we've delved into investigating various phenomena potentially linked to earthquakes to verify whether there are relationships with earthquakes and to clarify the mechanisms. As a result, we determined that electromagnetic phenomena were promising in prediction. However, it also turned out that it is difficult to predict earthquakes based on a single phenomenon, and that probabilistic prediction that combines multiple phenomena is necessary.

Outreach activities

In 2021, for disaster mitigation, we worked to have the *Honne no Kai* meetings followed by the Industrial Disaster Prevention Study Group (organized by the Aichi-Nagoya Resilience Co-Creation Center), which discloses information and discusses initiatives. In 2022, in order to attract the interest of many researchers in research on the antecedent phenomena of earthquakes, we conducted research with a focus on presenting papers and publishing enlightenment book.

❶❷ Authored by Nobuo Fukuwa, Jiji Press, Ltd.
❸ Authored by Toshiyasu Nagao, Business-sha Co., Ltd.
❹ Edited by Yuji Enomoto, Supervised by Toyota Konpon Research Institute Inc., Maruzen Publishing

RESEARCH FRONTLINE

05 Obtain new knowledge about coexistence with the Earth through analysis of symbiotic mechanisms of plants

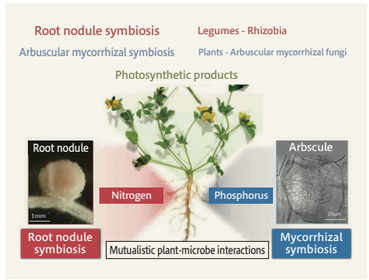
Analysis of symbiosis mechanisms in plants (rhizobia and mycorrhizal fungi)

Implementation period: 2022 to 2023 (planned) Principal researcher: Satoshi Kondo
Collaborative researchers: Naoya Takeda (Professor of Kwansei Gakuin University, 2022 to 2023), Akira Akamatsu (Assistant Professor of Kwansei Gakuin University, 2022 to 2023), Atsushi J. Nagano (Project Professor of Keio University, 2022 to 2023), Taro Maeda (Project Research Associate of Keio University, 2022 to 2023)

Effective utilization of symbiosis in nature (rhizobia: nitrogen supply, mycorrhizal fungi: phosphorus supply) is expected to help solve the environmental and energy problems caused by the large input of chemical fertilizers (nitrogen, phosphorus).
Scientists have identified and analyzed important symbiotic genes. However, the target of past research has been at the level of organs such as roots, and there are still many aspects of the symbiotic mechanism which remain unknown. Our research focuses on the cell and tissue level. Through RNA-sequencing analysis, we seek to gain knowledge on the mechanism of symbiosis, as well as on for application of root nodule symbiosis to plants other than legumes, and on root networks(underground intercellular communication) through mycorrhizal symbiosis.
In 2022, we conducted single-cell analysis of the model plant *Arabidopsis thaliana* (leaves) as a preliminary step to single-cell analysis of the symbiotic root (mycorrhiza) of *Lotus japonicus*. We found seven types of cell groups were in leaf cells, and also succeeded in identifying phloem cells, myrosin cells, and S cells. We published the results in Plant Cell Physiol. 64(2):234–247 (2023) doi:10.1093/pcp/pcac167.

Future developments

In 2022, based on the conditions for isolating single cells (protoplasts) of *A. thaliana* (leaves), we established conditions for isolating protoplasts from symbiotic roots of *L. japonicus*. In 2023, we will examine cell purification conditions and attempt single-cell analysis of the symbiotic roots of *L. japonicus*.



RESEARCH FRONTLINE

06 Explore new possibilities created by the fusion of matter/materials, life, the science of intelligence/intellect, and optical science

Cutting-edge science from the perspective of light

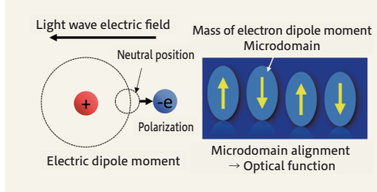
Implementation period: 2022 to 2023 (planned)
Principal researcher: Jun Hasegawa
Collaborative researcher: Takunori Taira (Specially Appointed Professor of Institute of Molecular Science, 2022 to 2023)

Light has existed since the birth of the universe and has always been at the forefront of science. For example, ancient Greeks studied why light made it possible to see things. In modern times, scientists are investigating whether light is a wave or a particle. From the perspective of light, we are conducting a two-year research project to investigate cutting-edge technologies and topics in science of matter/materials, life science, and the science of intelligence/intellect, and to find hints for identifying themes to research. In fiscal 2022, the first year of the project, we collected a wide range of information from the principal researcher's personal network, international conferences, and other literature, and found out the following expectations regarding light in each area.

science of matter/materials
Compact, high-power laser materials to accelerate laser fusion research.
Life science
By using laser light for which we can freely control the direction of vibration, elucidate the mystery that all protein molecules in living organisms are composed of specific optical isomers.
Elucidate and treat pain through research on the stimulus response of nerve cells to holographic light.
science of intelligence/intellect
Optical detection in the infrared region characterized by high thermal noise using phase-aligned coherence light and wavelength conversion materials.
Use quantum interference of light to detect weak optical signals.

Future developments

In fiscal 2023, we plan to focus on the interactions that occur among photons, We will determine which areas should be targeted for theme exploration and investigate the current situation and outlook to complete our research study.



RESEARCH FRONTLINE

07 Take on challenges in the synthesis of new antibiotics that will save humanity and in molecular design using information science

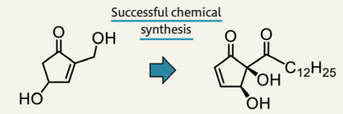
Advanced biomass utilization and drug discovery

Implementation period: 2019 to 2022
Principal researcher: Jun Hasegawa
Collaborative researcher: Hitoshi Kasai (Professor of Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, 2019 to 2022)

It is said that the number of deaths due to drug-resistant bacteria against which antibiotics are ineffective will surpass the number of cancer deaths and reach 10 million people a year by 2050. The development of new drugs is one of the most pressing issues. The molecule hygrophorone B (HB) contained in hygrophous species has the potential as a new drug, but only trace amounts can be collected. We succeeded in chemically synthesizing HB for the first time in the world by establishing a unique synthesis route from cyclopentenone, a raw material made from glucose. With the cooperation of the National Institute of Infectious Diseases, we evaluated HB and were able to confirm that it is more effective than existing antibiotics. Furthermore, we conducted exploratory research on the effectiveness of machine learning to develop unknown new drugs using HB. The key to development is translating the structure of the molecule into symbols, or descriptors that are recognized by computers. We proposed a concise descriptor that identifies the branching parts of the molecule. Specifically, we converted the structures of 12,000 molecules, for which there is experimental data on antibacterial effects into these descriptors and conducted machine learning. Based on the results, we identified two types of candidate molecules that had not been previously noticed as antibiotic. Through experiments to confirm the antibacterial effects of these molecules, their potential was clarified for efficient new drug discovery.

Outreach activities

We have applied for a patent on the chemical synthesis method for new antibiotics and published a paper on the method. We were also able to confirm the effectiveness of the design method using machine learning, so we completed this research by publishing our findings in a paper to make it widely useful for the development of the drug field.



Researchers Column

Continuing to carry on the work of our predecessors with gratitude and new hope

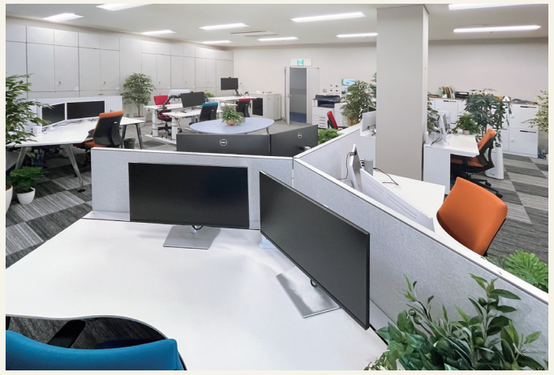
Former Director
Jun Hasegawa

In 1996, the Genesis Research Institute was established to be at the forefront of the Toyota group. Looking at documents from the time, it appears that advice was sought not only from the top of the group but also from academia, and there was heated discussion on what research themes the Institute should address. I have heard that all members of the Genesis Research Institute, including the president, gathered their own information on appropriate research themes and research partners.
When looking at past themes, new batteries, hydrogen energy, fuel synthesis, complete recycling based on lessons learned from the Edo Period, global environmental conservation, microorganisms, plant utilization, material creation, clusters, and other themes are still major issues faced by society today. Indeed, these past themes demonstrate the keen insight of our predecessors.
These themes were consolidated into five areas: cluster science, plant utilization, optical science, human beings and society, and disaster mitigation and Earth science. As new people were placed in charge of these themes, a desire emerged to create something concrete. In addition to transferring technology to Toyota Motor Corporation, researchers were able to communicate their findings outside of the Toyota group through giving presentations at academic conferences, writing papers, and publishing books. As the abovementioned themes were completed, researchers were able to enter the phase of exploring new themes once again.
The success of these efforts is thanks to everyone who discussed the ideal form of the Genesis Research Institute, our predecessors who established themes and passed them on to us, academics who provided sincere cooperation, and our colleagues who joined us in research efforts. I would like to express my deepest gratitude to all of these people.

WORK STYLE

Supporting new research endeavors through an ICT infrastructure that connects the Toyota Konpon Research Institute with academia, fostering the exchange of individuals and information.

Employees of the Toyota Konpon Research Institute are responsible for collaborating with academia and creating new knowledge. In addition to being able to utilize their own data, it is essential that these employees have an environment where they can connect and interact with various people and information from academia as necessary. We have introduced a zero-trust model to reduce security risks to an even lower level than before, and have created a cloud environment and high-speed environment for stress-free access anytime and from anywhere.



Hot desking that induces organic communication

Among diverse and flexible work styles such as telecommuting and flextime systems, when employees come to work, our Institute uses a hot desking layout with free seating which enables employees to spend even more creative time by establishing environments for engaging in lively discussion, freely sharing ideas, and concentrating quietly. In this environment, research coordinators discuss the future. Customers from outside the Institute can feel free to stop by and have a consultation or chat. We will continue to create a workplace where information is gathered and ideas are spread.

COMPANY PROFILE

As of July 2023

Company name	Toyota Konpon Research Institute Inc.
Established	June 11, 1996
Capital JNY	100 million
Location	Nishi-ku, Nagoya City Inside the Toyota Commemorative Museum of Industry and Technology
Representative Director	Takeshi Uchiyamada
President	Noboru Kikuchi
Directors	Tetsuro Toyoda Hiroyuki Wakabayashi Morito Oshita Hirofumi Inoue Hiroyasu Watanabe
Auditors	Hisaaki Takao Hirotaka Takeda
Business details	1. Research, investigation, and provision of technical information regarding future social predictions 2. Research, testing, and investigation of humanities and social sciences, natural sciences, and comprehensive technologies based on those sciences 3. Research, testing, and investigation regarding the development and use of science and technology, and the resulting effects and impacts 4. Research, testing, surveys, and the training and development of researchers and engineers conducted through mutual contracting or jointly with countries, administrative agencies, organizations, and research institutions
Shareholders	Toyota Motor Corporation Toyota Industries Corporation Aisin Corporation Denso Corporation Toyota Central R&D Labs., Inc. Aichi Steel Corporation JTEKT Corporation Toyota Auto Body Co., Ltd. Toyota Tsusho Corporation Toyota Boshoku Corporation Toyota Motor East Japan, Inc. Toyoda Gosei Co., Ltd.
History	June 1996 Established the Genesis Research Institute in the Toyota Commemorative Museum of Industry and Technology in Nishi-ku, Nagoya May 1997 Opened the East Tokyo Laboratory in the Cluster Research Laboratory of the Toyota Technological Institute, Ichikawa City, Chiba Prefecture March 2023 Closed the East Tokyo Laboratory July 2023 Changed the company name to Toyota Konpon Research Institute in an aim to become a research institute where the world's top diverse researchers gather

Note From the Editor

Thank you for reading our 2022 Annual Report. This is the first time that we have published annual report, and the report introduces our past efforts and new initiatives. Going forward, we will continue to raise awareness for our research institute among more people, broadly recruit like-minded colleagues, and engage in research that meets the needs of the times. We will persist in raising awareness for our research institute among an expanding circle of individuals, actively recruiting like-minded colleagues, and conducting research that addresses contemporary needs.