

## THE JAPAN PRIZE FOUNDATION

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Japan Prize News

No. 62 May 2019

# JAPAN PRIZE

## 2019 (35<sup>th</sup>) Japan Prize Presentation Ceremony

Two scientists from Japan and the U.S. honored in the presence  
of Their Majesties the Emperor and Empress  
at the last Japan Prize Presentation Ceremony of the Heisei era



On Monday, April 8th, the Japan Prize Presentation Ceremony was held at the National Theatre in the presence of Their Majesties the Emperor and Empress. The Japan Prize is an international award presented to individuals whose original and outstanding achievements in science and technology have served to promote peace and prosperity for mankind.

For the 2019 Japan Prize, Prof. Yoshio Okamoto, University Professor of Nagoya University, was awarded in the "Materials and Production" field for his leading contributions to the precision synthesis of helical polymers and development of practical chiral materials for separating chiral drugs. In the "Biological Production, Ecology" field, Prof. Rattan Lal, Distinguished University Professor of Soil Science at the Ohio State University, was awarded for his contributions to the sustainable soil management for global food security and mitigation of climate change. Both laureates were presented with a certificate of merit, a prize medal, and a cash prize of 50 million yen.

Each year, the Japan Prize Foundation receives nominations from prominent scientists and researchers worldwide, from which candidates are chosen through a rigorous year-long selection process. Of the fields eligible for the prize in 2019, the "Materials and Production" field received 270 nominations, and the "Biological Production, Ecology" field received 99 nominations.

### JAPAN PRIZE

The Japan Prize came into being in 1982 after the late Mr. Konosuke Matsushita, the founder of Matsushita Electric Industrial Co., Ltd. (now known as Panasonic Corporation), made a personal donation in response to the then government's wish to create a prestigious international prize for scientists from around the world as a token of gratitude to the international community. With cabinet endorsement, the prize was first awarded in 1985. The Japan Prize honors

those whose original and outstanding achievements are not only scientifically significant, but have also served to promote peace and prosperity for all mankind. Each year, the foundation designates two fields for award presentation in consideration of developments in science and technology. Each Japan Prize laureate receives a certificate of merit and a prize medal. A cash prize of 50 million yen is also presented to each prize category.

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“Materials and Production”

## Leading contributions to precision synthesis of helical polymers and development of practical chiral materials for separating chiral drugs

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**Prof. Yoshio Okamoto**

Born: January 10, 1941  
University Professor of Nagoya University,  
Chair Professor of Harbin Engineering University, China

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Message from the laureate

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It is truly an honor to be receiving the Japan Prize in the presence of Their Majesties the Emperor and Empress, distinguished guests, and ladies and gentlemen. I would like to express my heartfelt gratitude to the Japan Prize Foundation, the Selection Committee, and all the nominators for recognizing my research.

“The synthesis of unidirectional helical polymers”, which became the starting point of the research that I’m being recognized for, was first discovered back in 1979. This year being the 40th year anniversary since the discovery, I feel blessed to be receiving this honor on such occasion.

My research was initially driven by my curiosity in trying to demonstrate the existence of unidirectional helical polymers and was not aiming for the practical application of helical polymers.

However, with incredible fortune, I unexpectedly discovered that the helical polymer I synthesized showed high separation ability for enantiomers, which are compounds in a mirror-image relationship as in the case

of left and right hands.

From there on, I succeeded in the practical application of this ability and discovered new polysaccharide-based separation materials before being recognized for this award.

I would like to express my utmost gratitude to all the colleagues I collaborated with in my research and the students who assisted me in conducting the experiments. Also, since the Japan Prize places a strong emphasis on practical applications, I would like to sincerely thank Daicel Corporation for successfully commercializing the fruits of my basic research.

I have been involved in the research of polymers and chiral compound for many years and it gives me great joy to know that the receiving of this award will encourage researchers, especially those that are young, who are currently undertaking research in these fields.

Thank you.

Yoshio Okamoto

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“Biological Production, Ecology”

## Sustainable soil management for global food security and mitigation of climate change

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### Prof. Rattan Lal

Born: : September 5, 1944  
Distinguished University Professor of Soil Science  
Director, Carbon Management and Sequestration Center  
The Ohio State University

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#### Message from the laureate

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Their Majesties the Emperor and Empress, distinguished guests, and ladies and gentlemen, it is a matter of great honor and privilege for me to receive the 2019 Japan Prize for the research on “Sustainable Management of Soil and Food Security and Climate Change.” For this, I am especially grateful to the Japan Prize Foundation for the unique opportunity to represent soil science globally, but specifically in relation to essential ecosystem services including food and nutritional security, adaption and mitigation of climate change, and advancing the Sustainable Development Goals of the United Nations. I would also like to thank my fellow soil scientists from Japan, especially Prof. Takashi Kosaki, Prof. Kazuyuki Inubushi and others. My special thanks are due to President

and Mrs. Drake, Dean Kress, Vice Provost Prof. Latz, Sr. Vice President Dr. Morley Stone, and Director Jeff Sharp for their kind support, encouragement and collaboration. I appreciate the support of staff, students, postdocs and visiting scholars of the Carbon Management and Sequestration Center and of the SENR. I thank my wife, Sukhvarsha, and our family in the United States, Canada and India for their compassionate understanding. Thank you for the honor and privilege.

Rattan Lal

# Presentation Ceremony



The 2019 (35th) Japan Prize Presentation Ceremony was held at the National Theatre in the presence of Their Majesties the Emperor and Empress. The magnificent occasion was celebrated by approximately 1,000 attendees, including distinguished guests such as Mr. Tadamori Oshima, Speaker of the House of Representatives, Mr. Chuichi Date, President of the House of Councillors, Mr. Naoto Otani, Chief Justice of the Supreme Court, Mr. Masahiko Shibayama, Minister of Education, Culture, Sports, Science and Technology, Mr. Takuya Hirai, Minister of State for Special Missions, as well as prominent academic and business figures.

At the presentation ceremony, which opened with a glorious rendition of "Overture to the Japan Prize Ceremony - Overture Japan", family and friends watched as the laureates were presented with a certificate of merit and a prize medal by Chairman Yoshio Yazaki of the Japan Prize Foundation. The laureates received warm applause from the audience as they held up the prize medals and expressed their joy in their acceptance speeches.

During the ceremony, President Komiyama of the Japan Prize Foundation also announced the 2019 launch of the "Japan Prize Heisei Memorial Research Grant Program", a new research grant program to convey our heartfelt appreciation to Their Majesties the Emperor and Empress for the many years of support for the Japan Prize since its inception. The name of this new program was inspired by the kindness of Their Majesties who has always shown great interest in the research activities of young researchers and offered words of encouragement. At the same time as expressing the foundation's deepest gratitude for the kindness that Their Majesty has bestowed upon the Japan Prize, we hope this program will become an embodiment of their legacy. We will significantly revise and enrich our current "Research Grants for Young Researchers" in order to offer a program under which young researchers can excel under a free and flexible mindset.

The ceremony was followed by a commemorative concert, in which Tokyo Geidai Symphony Orchestra performed movement 1 of Mozart's "Eine Kleine Nachtmusik" and "Let it be" by Paul McCartney as requested by Prof. Okamoto, and "Scene" and "Waltz of Flower" from Tchaikovsky's ballet suites "Swan Lake" and "The Nutcracker" as requested by Prof. Lal.



Prof. Okamoto and his son



Prof. and Mrs. Lal



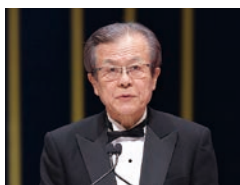
Their Majesties the Emperor and Empress congratulating the laureates



Commemorative concert by the Tokyo Geidai Symphony Orchestra



Congratulatory address by H.E. Mr. Oshima, Speaker of the House of Representatives



Opening remarks by President Komiyama of the Japan Prize Foundation



The laureate announcement by Chairman Asashima of the 2019 Japan Prize Selection Committee

## About the Japan Prize Heisei Memorial Research Grant Program

As an avid researcher of fish and animals, His Majesty the Emperor has always been passionate about the advancement of science and technology and its contribution to society. Since the inception of the Japan Prize in 1985, His Majesty has honored and acknowledged the 96 successive laureates by bestowing his presence at all the ceremonies from the very first through to the most recent 35th ceremony that took place this April, which became the last ceremony of the Heisei era.

Every year since the 7th Japan Prize of 1991, His Majesty has also bestowed his presence at the post-banquet social gathering, proposed by His Majesty himself, for a deep discussion on research and has offered words of encouragement to young researchers.

We hope that the "Japan Prize Heisei Memorial Research Grant Program", a new research grant program that's scheduled to start this year, can live up to the expectation of His Majesty and his passion for science and technology.

# Banquet



Following the presentation ceremony, a banquet in honor of the laureates was held at Hotel New Otani Tokyo. In response to a toast given by His Majesty the Emperor, over 300 guests raised their glasses to once again congratulate the two laureates on their achievements. Amid the beautiful strains performed by a string quartet and a harp, Their Majesties the Emperor and Empress engaged in pleasant conversation with the laureates and their families seated by their side. The banquet, which spanned an hour and a half, came to a close with a congratulatory message from President Date of the House of Councillors and acknowledgment speeches from the laureates.

Prof. Okamoto reiterated that fast and accurate separation analysis of enantiomers is crucial for pharmaceutical drug development because many pharmaceutical drugs have enantiomers. As more advancements are made in his research area, he hopes to see that young researchers will further develop his technique to realize the large-scale and low-cost separation of many enantiomers including pharmaceutical drugs.

Prof. Lal explained that soil is essential to all life on earth and the risks posed by the degradation of soil and our environment has been increasing along with the world population. In order to combat such issues as global food security, he advocated that we must improve the environment by restoring soil's health and protecting natural resources.

Prof. Lal stated that the award is a recognition of the significance of soil science and the world's agricultural industries, and thanked the prize for raising people's awareness on the importance of soil and its sustainable management for human health and the conservation and restoration of nature. He also stated that he will donate the prize money to support research and education at The Ohio State University's Carbon Management and Sequestration Center.



|| Toast by His Majesty the Emperor

|| Congratulatory address by H.E. Mr. Date, President of the House of Councillors



|| Opening address by Chairman Yazaki of the Japan Prize Foundation

|| Acknowledgment by Prof. Okamoto

|| Acknowledgment by Prof. Lal

# 2019 (35<sup>th</sup>) Japan Prize Commemorative Lectures

On Wednesday, April 10, the commemorative lectures by Prof. Yoshio Okamoto and Prof. Rattan Lal were held at the Ito International Research Center, University of Tokyo. In front of approximately 300 members of the audience, comprised of researchers and the general public, Prof. Okamoto spoke on the "Synthesis of helical polymers and their separation into left- and right-handed molecules", while Prof. Lal spoke on the "Soil management for global food security and environmental conservation".

Prior to the lectures, roundtable discussions were held between the two laureates and young researchers. In both sessions, Prof. Okamoto, Prof. Lal and the attending young researchers introduced themselves and their research topics, which were followed by a lively questions and answers session.

Both meetings resulted in active discussions, through which the laureates gave their heartfelt encouragement to the young up-and-coming researchers.



"Materials and Production" field

Topic

## The synthesis of one-handed helical polymers and its application towards enantiomeric separation

(Prof. Yoshio Okamoto)

When a compound and its mirror image counterpart are inversely structured in the same way left and right hands are, it is said to be "chiral", and the two molecular counterparts are called "enantiomers".

The chemical synthesis of a compound results in a mixture that contains equal quantities of left- and right-handed compounds (racemates). The separation of this mixture may be necessary if the resulting product is to be used in the manufacturing of high precision chemicals.

At present, high-performance liquid chromatography that uses "chiral columns" is the most widely used method of separation. The "chiral column", which has become indispensable for research and manufacturing, was first commercialized in 1982 using the one-handed helical polymer, which Prof. Okamoto was the first in the world to successfully synthesize.

The left- and right-handed enantiomers can have different physiological effects, therefore, it may be necessary to separate the synthesized mixture to obtain the compound with desired medical efficacy, aroma or taste. When a synthesized compound is used in pharmaceutical drugs, the wrong enantiomer can cause unintended side effects. Therefore, it has been recommended since the 1990s that enantiomers be separated during the manufacturing process.

There are many substances that have a different physiological effect among its enantiomers, including penicillin (antibiotic), dopa (a drug for treating Parkinson's disease), naproxen (painkiller), monosodium glutamate (flavor enhancer), menthol (algae-facient) and aspartame (artificial sweetener). Many major pharmaceutical drugs that are sold in large quantities, such as lipid-lowering agents, psychotropic drugs and gastric acid secretion inhibitors, have been manufactured by enantiomeric separation.

The realization of the chiral column was made possible as a result of the enantiomer-differentiating ability of one-handed helical "poly(triphenylmethyl methacrylate)", which Prof. Okamoto synthesized in 1979.

Up until the success of this "helix-sense-selective polymerization", no vinyl polymers were known to retain a stable helical structure. A one-handed helical polymer itself is "chiral" in nature. Prof. Okamoto coated this helical polymer onto silica gel and packed it into a column.

When a mixture of enantiomers is injected into the column with the solvent, one of the enantiomers will be bound by its interaction with the helical polymer, thereby letting the other enantiomer flow out first, as it does not interact with the helical polymer of different twist direction. The basic mechanism of "chiral column" relies on this time difference to separate enantiomers.

Some polymers with a helical structure, such as proteins and DNA that carries biological structures and information, occupy important positions in the natural world. Their constitutions were first elucidated during the 1950s. A large number of helical polymers have been synthesized throughout the world since Prof. Okamoto's first breakthrough, and this area of research has grown into a major area of synthetic organic chemistry.

Prior to "helix-sense-selective polymerization", Prof. Okamoto in 1977 succeeded in "asymmetric-selective polymerization" when he selectively polymerized one of the enantiomers from the racemate of methacrylic acid ester. This was the first time that a chiral polymer was synthesized from a non-chiral compound. The key to the success of this polymerization reaction was "sparteine", a reagent derived from legume alkaloids that he stumbled upon through research literature.

In search of easier to use column fillers, Prof. Okamoto has since developed numerous substances by chemically modifying natural polymers, cellulose and amylose. Today, a wide variety of chiral columns are commercially available, and depending on the purpose, they can separate almost 90% of enantiomeric compounds.

Ever since its invention, the "chiral column" has constantly been evolving. With the development of chemically bonded fillers that do not depend on the solvent, and with the introduction of new technologies such as the pseudo-moving-bed that enables large-scale separation greater than that of high-performance liquid chromatography, the range of applications for separation of enantiomers is becoming broader than ever.



"Biological Production, Ecology" field

Topic

## Sustainable soil management for global food security and mitigation of climate change

(Prof. Rattan Lal)

As a soil physicist, Prof. Lal began researching and addressing the issue of soil erosion in Africa's sub-Saharan region during the 1970s. Through this effort, he established the "no-tillage cultivation method", an agricultural technique based on the concept of not cultivating the soil so that a stable level of soil organic matter can be maintained while increasing the crop yield, and spread this technique throughout the world.

After becoming a professor at Ohio State University in 1987, Prof. Lal conducted research on the relationship between soil, the food security issue and global environmental issues using his fieldwork research results. Based on the findings, he has since been actively promoting the importance of soil management. His efforts have led to the realization of many international measures including the initiative to "increase soil carbon by 4/1000 per year".

Prof. Lal began the commemorative lecture on his conclusion by stating "we must have faith in the soil". He explained that the rhizosphere is the only place in the universe that can create life from dead organisms, that the soil up to 40 cm deep globally holds 850 gigatons of organic carbon, and that the benefits of the ecosystem is created by the interrelatedness of the circulation of water, carbon, nitrogen, phosphorus and sulfur. On top of these findings, he cited throughout the lecture the abundant data he collected and analyzed over the years.

On the food security issue, he pointed out that "The population has grown a thousandfold in the 10,000 years since humans began farming. Cultivated land has increased while forests have shrunk. Due to soil degradation caused by the kind of agriculture that deprives carbon in the soil, the function of the ecosystem has been weakened. The resulting prevalence of hunger and malnutrition has even caused wars and refugees". In order to break this vicious circle, he strongly noted that "We must make our soil fertile and productive again".

In regard to the global environmental problems, Prof. Lal quantitatively illustrated the history of how the different approach to land use has led to an increase in atmospheric carbon dioxide, along with carbon emissions from the burning of fossil fuel that began taking place after the industrial revolution. He shared his unique viewpoint on this matter, saying "The upper limit of atmospheric carbon dioxide concentration acceptable from the viewpoint of global warming is 560 ppm, and we are currently at 410 ppm. This difference is equivalent to 320 gigatons of carbon, and that is also the only amount we are allowed to emit in the future. Policymakers must figure out how to divide the 320 gigatons among the global population of 78 billion people.

Based on these findings, Prof. Lal concluded the lecture by discussing the changes needed in agriculture to support the ever-growing global population. He stated that "Currently, we use huge areas of land and large amounts of water for agriculture and livestock farming, which also emits a significant amount of greenhouse gases. In the future, we must aim for the kind of agriculture that produces more while using less water and fertilizers, and reducing the area of cultivated land so that we can return more land back to nature". As concrete examples, Prof. Lal suggested increasing the organic carbon in soil through the use of agricultural residues, as well as precision agriculture in which the processes are fine-tuned according to the condition of farmland and crops.

Prof. Lal's lecture was not a reflection of his past research achievements. Instead, his commemorative lecture was a strong proposal to the world on the future of soil, food security and climate change based on his ongoing research.

# Japan Prize Week

J A P A N P R I Z E W E E K P H O T O S

4/8  
(MON)

Presentation Ceremony



Banquet



4/9  
(TUE)

Courtesy Call on the Japan Academy



Academic Roundtable Discussion



4/10  
(WED)

Commemorative Lectures at the Ito International Research Center



4/11  
(THU)

Visit to the Foundation Office



Courtesy Call on U.S. Ambassador's Residence



4/13  
(SAT)

Sightseeing in Kyoto



Katsura Imperial Villa



Shinshin-An

## Fields Eligible for the 2020 Japan Prize

The fields eligible for the 2020 (36<sup>th</sup>) Japan Prize are “Electronics, Information and Communication” and “Life Science” The Japan Prize Foundation has received numerous nominations from the 15,000 registered nominators worldwide, and the rigorous selection process by the foundation's Japan Prize Selection Committee has already begun. The announcement of winners is scheduled to take place in January 2020, followed by a presentation ceremony in April.

Area of  
Physics, Chemistry, Informatics, Engineering

### Electronics, Information, Communication

#### Background and Rationale:

The successive birth of various technologies in fields of electronics, information and communication has greatly contributed to human society. Its progress has been remarkably fast, and in recent years, we are seeing innovative developments in basic technologies, such as artificial intelligence, big data, IoT, robotics, semiconductor devices, optical/wireless network and information security. As a result, for example, the accumulation of enormous amount of information and its sophisticated analysis, made possible by the convergence of the physical and cyber space, are beginning to revolutionize the industrial structure and human lifestyle.

It is highly anticipated that such technological advancements will not only facilitate economic development but also resolve societal issues, thereby contributing to the realization of a safe, secure and sustainable society that enables innovative lifestyles.

#### Achievement Eligible:

The 2020 Japan Prize in the field of “Electronics, Information, Communication” is awarded to an individual(s) who has achieved scientific and technological breakthroughs, such as the development of essential technologies or systems that have contributed significantly to the creation of new industries, innovations in production technology, the realization of a safe and secure society, and improvements in amenity of life, as well as advances in basic science and technology that are highly likely to promote the further development of society.

Area of  
Life Science, Agriculture and Medicine

### Life Science

#### Background and Rationale:

In recent years, major advances in life science driven by innovative analysis technology have led to the elucidation of many complex yet subtle mechanisms of life.

Today, analysis technologies such as DNA sequencing technology capable of rapidly determining the entire genome information and its gene expression state, genome editing technology that can modify genetic information in a targeted manner, and imaging technology capable of visualizing various layers of anatomy from intracellular organelle to complex brain tissues, have especially become well established and widely accessible, thereby opening up a whole new dimension in the realm of life science.

It is anticipated that progress in the understanding of the foundation of life phenomena while upholding bioethics will contribute toward the welfare of mankind by creating new medical care and bringing about wisdom for sustainable human development.

#### Achievement Eligible:

The 2020 Japan Prize in the field of “Life Science” is awarded to individual(s) who has made significant contributions to society by achieving scientific and technological breakthroughs, such as the discovery of new life phenomena, proposal of paradigm shifts, and technological innovations that deepen the understanding of biological functions.

## The Japan Prize Foundation

The Japan Prize Foundation was established in 1982, with the aim of contributing to the further development of science and technology. In addition to recognizing outstanding achievements with the Japan Prize, the Foundation has been promoting science and technology by hosting the "Easy-to-understand Science and Technology Seminars" and awarding Research Grants to help nurture young scientists.



#### Research Grants

The Foundation provides research grants to scientists and researchers under 35 years of age. Every year, the Foundation selects projects in the same fields as the corresponding Japan Prize and gives one million Japanese yen for a project. In 2015, studies in “Clean & Sustainable Energy” were added as an eligible field of study to the two fields designated for the 2015 Japan Prize. The Foundation awarded research grants to 270 young scientists since the program's inception in 2006.

We reorganize and expand the current system drastically and we will start as a completely new one named “Japan Prize Heisei memorial Research Grant Program” this year.



#### “Easy-to-Understand Science and Technology Seminars”

For junior and senior high school students, the Foundation holds a series of seminars on advanced technologies commonly used in everyday life by inviting Research Grant recipients as lecturers. They explain state-of-the-art technologies in plain terms. The program began in March 1989 and has since executed more than 300 seminars across Japan.



#### Stockholm International Youth Science Seminar (SIYSS)

Each year, the Japan Prize Foundation provides an opportunity for young scientists to exchange opinions with their peers on an international level by sending two students to the Stockholm International Youth Science Seminar hosted by the Swedish Federation of Young scientists with the support of the Nobel Foundation. Young scientists from Japan and elsewhere in the world attend various events during Nobel Week in Stockholm. Since the program started in 1987, the Japan Prize Foundation has provided this valuable opportunity to 62 undergraduate/graduate students.