JAPAN PRIZE

2022

SINCE 1985

THE JAPAN PRIZE FOUNDATION

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Significance of the JAPAN PRIZE

Chairman

Yoshio Yazaki

The peace and prosperity of mankind are the common aspirations for people of the world. When looking back over the history of humanity, science and technology have played an immense role in this cause.

The Japan Prize is an international award presented to individuals whose original and outstanding achievements are not only scientifically impressive but have also served to promote peace and prosperity for all mankind. Since its inception in 1985, the Foundation has awarded 104 laureates from 14 countries as of this year.

The most notable feature of the Japan Prize is its strong emphasis on "contribution to society", as clearly stated in the philosophy which the prize was founded on. When I look back over the pedigree records of the 104 Japan Prize recipients from this perspective, I strongly feel that it reflects the overlapping history of the progress of science and technology and the peace and prosperity of mankind.

Looking back on the establishment of the Japan Prize, it can be said that there was a strong desire to "express Japan's gratitude to international society" for the fruits of science and technology of the world that enabled Japan to achieve rapid post-World War II reconstruction and development.

The strong desires and aspirations of the first president, Konosuke Matsushita, and many of the predecessors involved in the creation of the prize still live on in Matsushita's philosophy of "Lifelong Ambition".

Every year in April, the Presentation Ceremony are held in Tokyo in the presence of Their Majesties the Emperor and Empress of Japan, and are also attended by prominent figures such as the Speaker of the House of Representatives, the President of House of Councilors, the Chief Justice of the Supreme Court, as well as other distinguished guests, including eminent academics, researchers and representatives of political and business circles. I would like to express my deepest appreciation to all those who are involved, for without their passionate support, the Japan Prize would not exist today.

As was the case so far, the progress of science and technology will continue to play a significant role in mankind's peace and prosperity into the future. With such strong desires and aspirations, the Japan Prize will strive to promote the further advancement of science and technology.

JAPAN PRIZE - Peace and prosperity for mankind

President

Hiroshi Komiyama

The Earth is just one of the countless planets in the vast universe. Following the birth of our planet 4.5 billion years ago, our ancestors only emerged during the last few millions of years, a very recent event in terms of cosmic scale. Since then, mankind as a species has continued to prosper and went on to develop civilization. While people's lives have greatly improved, the progress has been extremely slow. However, since the industrial revolution 200 years ago, the situation has completely changed. Especially since the turn of the 20th century, the pace of development has accelerated significantly, thereby making people's lives even more prosperous. The force that has been driving this development is science and technology.

For example, people now live much longer. In fact, almost all people throughout history lived very short lives. Even in the early 20th century, the average life span was only 31 years, but that has now increased to 72 years. Since the long-standing dream of longevity has now been realized, we must have succeeded in forming a civilization.

The Japan Prize was established to honor the achievements in science and technology that contribute to the peace and prosperity of mankind. When looking back over the history of achievements by the Japan Prize recipients, I am strongly reaffirmed that it reflects the prosperity of today's society and the major role of science and technology that helped to bring it about. Convinced of its significance, I will continue to devote myself to the Japan Prize and its cause.

At the same time, I cannot deny the anxiety that hangs over the future of humanity. Will we able to maintain our beautiful planet? Can humanity continue to prosper without leaving anyone behind? These basic questions are unavoidable and must be confronted. I am confident that the Japan Prize will play a crucial role in promoting science and technology that will answer such questions.

The advancement of science has blessed us with a huge body of accumulated knowledge. Knowledge is the most prized asset of humanity. Because of its sheer volume, it has become difficult to grasp the overall picture of just how much knowledge we now have. This, coupled with the increasing complexity of prosperous society, and the prosperity attained as a result of making changes to our planet, has brought about anxiety over our future.

In other words, scientists must confront this problem head on, as the advancement of science itself is a source of anxiety for the future. In order to solve the various issues we face, we must work together by transcending the fragmented fields of knowledge.

Despite the possibility that science and technology may be used for a bad cause, I'm convinced that we also possess the "wisdom" to overcome such a dilemma.

As we contemplate on the future of civilization, science and technology, the Foundation will establish the "Japan Prize Heisei Memorial Research Grant Program" this year in order to express our sincerest appreciation to His Majesty the Emperor Emeritus, who has blessed us with great support for the Japan Prize since the first award ceremony in 1985. We hope the program will encourage motivated researchers to take on further challenges.

The Foundation will continue to contribute to the peace and prosperity of mankind through the Japan Prize, research grants and the promotion of science and technology education.

The Japan Prize Foundation

Name

The Japan Prize Foundation

Objectives

Bearing in mind the fact that peace and prosperity for mankind is the common aspiration of all people, the Japan Prize Foundation encourages research that will contribute to the development of science and technology, and promotes the comprehensive spread and development of ideas and information in science and technology.

Activities

The Foundation conducts the following activities to accomplish its objectives:

1) Recognize outstanding achievements in science and technology with the Japan Prize
2) Encourage the study of science and technology through research grants and promotional activities
3) Promote the diffusion of knowledge and philosophy in science and technology through various activities including dissemination of information materials and research papers, and seminars
4) Other activities to fulfill the objectives of the Foundation

History

1982	The Japan Prize Preparatory Foundation is established.
1983	The establishment of the Japan Prize is endorsed by the Cabinet.
1985	The 1st Japan Prize Presentation Ceremony is held.
1989	The Foundation starts hosting “Easy-to-understand Science and Technology Seminars”.
2006	The Foundation starts awarding Research Grants.
2010	As of October 1, 2010, the Foundation changes its legal status to a Public Interest Incorporated Foundation and renames itself to “The Japan Prize Foundation”.
2020	Launched the Japan Prize Heisei Memorial Research Grant Program(Reorganization of the research grant project)

Cabinet Endorsement

The official position of the Japanese Government is that the Japan Prize, to be bestowed by the Science and Technology Foundation of Japan*, will serve to deepen the understanding of the role played by science and technology in furthering world peace and prosperity, thereby making a vital contribution to the positive development of mankind. Based on this judgment, the government agencies concerned are urged to offer whatever cooperation necessary in all phases pertinent to this prize.

(Cabinet Endorsement, October 28, 1983)

* Current “Japan Prize Foundation”

Directors, Auditors and Councilors of the Foundation

Chairman, Directors, Auditors

Chairman
Yoshio Yazaki
Chairman, Board of Regents, Tokyo Medical University

President
Hiroshi Komiyama
Chairman of the Institute,
Mitsubishi Research Institute, Inc.
The 28th President of the University of Tokyo

Managing Director
Yasuhiro Mashiko
Secretary General, The Japan Prize Foundation

Directors
Masahiro Ando
Former Director General, State Guest Houses

Hiroto Ishida
President, Honda Foundation

Hideaki Kobayashi
Emeritus Professor
Okinaga Research Institute of Teikyo University

Masayuki Matsushita
Special Corporate Advisor, Panasonic Holdings Corporation

Michiharu Nakamura
President Emeritus,
Japan Science and Technology Agency

Auditors
Masakazu Kubota
Vice Chairman & President, Keidanren

Hiroshi Ozaki
Senior Advisor, Osaka Gas Co., Ltd.

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Masayuki Oku
Honorary Advisor, Sumitomo Mitsui Financial Group, Inc.

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Councilors
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CEO, the Tokyo Foundation for Policy Research
Senior Advisor, Japan Society for the Promotion of Science

Kazuhiko Fushiya
Former President, Board of Audit of Japan

Shingo Haketa
Director, Showa-kan

Michinari Hamaguchi
Director General, Strategic Center of Biomedical Advanced Vaccine, Research and Development for Preparedness and Response, Japan Agency for Medical Research and Development
Counselor to the President, Japan Science and Technology Agency

Tomonori Kudoh
Chairman, Sports Safety Association

Hiroshi Matsumoto
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Hideo Miyahara
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Ryozo Nagai
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Hiroshi Tomono
Senior Advisor, Nippon Steel Corporation

Yukako Uchinaga
Board Chair, Japan Women's Innovative Network

Takeshi Uchiyamada
Chairman of the Board, Toyota Motor Corporation

Lifetime Advisor

Taro Nakayama
Former Member of the House of Representatives

Special Advisor

Hiroyuki Yoshikawa
Former President, The University of Tokyo

(alphabetical order, titles as of April 1, 2022)

Main Activities of the Foundation

JAPAN PRIZE

The creation of the Japan Prize was motivated by the Japanese government's desire to "contribute to the development of science and technology worldwide by establishing a prestigious international award". Supported by numerous private donations, the Japan Prize was established in 1983 with a cabinet endorsement.

This award honors scientists and researchers worldwide who are recognized for having contributed signifi cantly to the peace and prosperity of humankind through their original and outstanding achievements that have greatly advanced the progress of science and technology.

The eligible fields of this award cover all fields of science and technology. Every year, two fields for the award presentation are chosen by considering the developments in science and technology.

As a general rule, one award is given for each field and each laureate receives a certificate of merit, a prize medal and a cash prize.

The Presentation Ceremony is held annually in the presence of Their Majesties the Emperor and Empress of Japan and is also attended by the Speaker of the House of Representatives, the President of House of Councilors, the Chief Justice of the Supreme Court, and various ministers as well as eminent figures from various circles.

JAPAN PRIZE

The Japan Prize logo was designed by Mr. Yusaku Kamekura, then President of Japan Graphic Designers Association Inc. Commenting on his work, Mr. Kamekura said, "I used the image of the sun, the source of all energy for its primary design. The circles were added to represent perfection and truth".

Research Grants

The “Japan Prize Heisei Memorial Research Grant Program” is named after Their Majesties the Emperor Emeritus and Empress Emerita, who have been interested in the research activities of young scientists and have encouraged them for many years.

The Foundation provides research grants to scientists mainly under 45 years of age. Every year, the Foundation selects four to eight scientists who undertake knowledge-integrated research that contribute to solving social issues, and gives five to ten million yen.

The Foundation encourages international collaboration of scientists beyond their expertise.

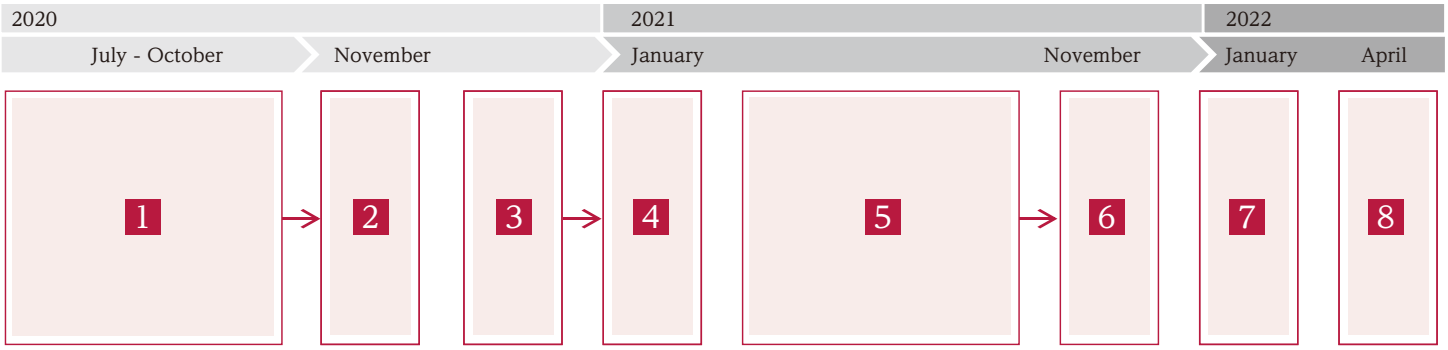
(An applicant must belong to a research organization in Japan.)

“Easy-to-Understand Science and Technology Seminars”

The Foundation holds a series of public and student seminars on advanced technologies commonly used in everyday life by inviting experts, who will 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 by the end of 2019.

Nomination and Selection Process

Nomination and Selection Process for the 2022 Japan Prize Laureates



1 Consider the eligible fields for the 2022 Japan Prize
(Board of Directors)
Materials and Production
Biological Production, Ecology/Environment

2 Determine the eligible fields for the 2022 Japan Prize
(Board of Directors)

3 Invite the nominations

4 Closing of the nominations

5 Japan Prize (Selection Committee)
Materials and Production
(Selection Subcommittee)
Biological Production, Ecology/Environment
(Selection Subcommittee)

6 Selecting the Laureates of the 2022 Japan Prize
(Board of Directors)

7 Announce the Laureates of the 2022 Japan Prize

8 The 2022 Japan Prize Presentation Ceremony

・Every November, the Field Selection Committee of The Japan Prize Foundation designates and announces two fields in which the Japan Prize will be awarded two years hence. At the same time, the Foundation calls for over 15,000 nominators, strictly comprised of prominent scientists and researchers from around the world invited by the Foundation, to nominate the candidates through the Web System. The deadline for nominations is the end of January of the following year.

・For each field, a Selection Subcommittee conducts a rigorous evaluation of the candidates' academic achievements. The conclusions are then forwarded to the Selection Committee, which conducts evaluations of candidates' achievements from a wider perspective, including contributions to the progress of science and technology, and significant advancement towards the cause of world peace and prosperity, and finally the selected candidates are recommended for the Prize.

・The recommendations are then sent to the Foundation's Board of Directors, which makes the final decision on the winners.

・The nomination and selection process takes almost two years from the time that the fields are decided. Every January, the winners of that year's Japan Prize are announced. The Presentation Ceremony is held in April in Tokyo.

Fields Selection Committee and Selection Committee

■ Fields Selection Committee for the 2023 Japan Prize

Chairperson

Michiharu Nakamura

Counselor to the President
Japan Science and Technology Agency
Director, The Japan Prize Foundation

Vice Chairperson

Kazuhito Hashimoto

President
National Institute for Materials Science

Kohei Miyazono

Distinguished University Professor
Professor, Department of Molecular Pathology,
Graduate School of Medicine, The University of Tokyo

Members

Yozo Fujino
President, Josai University
Professor Emeritus, The University of Tokyo
Professor Emeritus, Yokohama National University

Ken Furuya
Professor
Graduate School of Science and Engineering
Soka University
Professor Emeritus, The University of Tokyo

Masaru Kitsuregawa
Director General
National Institute of Informatics
University Professor, The University of Tokyo

Kazuo Kyuma
President
National Agriculture and Food Research Organization

Eiichi Nakamura
University Professor
Department of Chemistry, Graduate School of Science, The University of Tokyo

Tomoko M. Nakanishi
President, Hoshi University
Professor Emeritus / Project Professor, The University of Tokyo
Commissioner, Japan Atomic Energy Commission

Yuichi Sugiyama
Distinguished Professor
Faculty of Pharmaceutical Sciences,
Josai International University
Professor Emeritus, The University of Tokyo
Honorary Scientist, Riken

Mariko Takahashi
Journalist
Former The Science Coordinator,
The Asahi Shimbun

Masayuki Yamamoto
Professor Emeritus, The University of Tokyo
Professor Emeritus, National Institute for Basic Biology

(alphabetical order, titles as of April 1, 2022)

■ Members of the 2022 Japan Prize Selection Committee

Chairperson

Makoto Asashima

Deputy Director General of Advanced Comprehensive Research Organization,
Research Professor, Teikyo University
Academic Advisor
Japan Society for the Promotion of Science
Professor Emeritus, The University of Tokyo

Deputy Chairperson

Yoichiro Matsumoto

Professor Emeritus
The University of Tokyo

Members

Mariko Hasegawa
President
The Graduate University for Advanced Studies, SOKENDAI

Hiroto Ishida
Director
The Japan Prize Foundation

Kazunori Kataoka
Vice Chairperson, Kawasaki Institute of Industrial Promotion
Director General, Innovation Center of NanoMedicine (iCONM)
Professor Emeritus, The University of Tokyo

Masayuki Matsushita
Director
The Japan Prize Foundation

Kyosuke Nagata
President
University of Tsukuba

Hideyuki Okano
Professor
Keio University School of Medicine

Tatsuya Okubo
Executive Vice President, Professor
School of Engineering, The University of Tokyo

Hiroto Yasuura
Director General
Fukuoka Asian Urban Research Center
Professor Emeritus, Kyushu University

■ Selection Subcommittee for the “Materials and Production” field

Chairperson

Kazunori Kataoka

Vice Chairperson
Kawasaki Institute of Industrial Promotion
Director General
Innovation Center of NanoMedicine (iCONM)
Professor Emeritus, The University of Tokyo

Deputy Chairperson

Toru Okabe

Director General, Professor
Institute of Industrial Science, The University of Tokyo

Members

Kazunari Akiyoshi
Professor
Graduate School of Engineering, Kyoto University

Katsuhiko Ariga
Principal Investigator
WPI International Center for Materials Nanoarchitectonics, National Institute for Materials Science

Atsushi Fukuoka
Professor
Institute for Catalysis, Hokkaido University

Jian Ping Gong
Professor
Faculty of Advanced Life Science, Hokkaido University

Yuichi Ikuhara
Professor
Graduate School of Engineering, The University of Tokyo

Koji Ishibashi
Chief Scientist
Cluster for Pioneering Research, RIKEN

Nobuharu Iwasawa
Professor
School of Science, Department of Chemistry, Tokyo Institute of Technology

Noboru Kikuchi
President, Genesis Research Institute, Inc.
Managing Director
Toyota Physical and Chemical Research Institute

Yasuhiro Koike
Distinguished Professor
Keio University

Kazue Kurihara
Professor, New Industry Creation Hatchery Center, Tohoku University
Professor Emeritus, Tohoku University

Tamio Oguchi
Specially Appointed Professor
Graduate School of Engineering Science,
Osaka University

Hideyuki Yasuda
Professor
Graduate School of Engineering, Kyoto University

■ Selection Subcommittee for the “Biological Production, Ecology/Environment” field

Chairperson

Mariko Hasegawa

President
The Graduate University for Advanced Studies, SOKENDAI

Deputy Chairperson

Taikan Oki

Professor
Graduate School of Engineering, The University of Tokyo

Members

Norichika Kanie
Professor
Graduate School of Media and Governance, Keio University

Eiiti Kasuya
Associate Professor
Faculty of Science, Kyushu University

Masakado Kawata
Professor
Graduate School of Life Sciences, Tohoku University

Mayuko Nakamaru
Associate Professor
School of Environment and Society, Tokyo Institute of Technology

Tohru Nakashizuka
President
Forest Research and Management Organization
Director General, Forestry and Forest Products Research Institute

Sakae Shibusawa
Appointed Professor, Tokyo University of Agriculture and Technology
Project Professor, Keio University

Toru Shimada
Professor
Faculty of Science, Gakushuin University

Shinichi Shogenji
Dean, Professor
Faculty of Food and Agricultural Sciences, Fukushima University

Toshio Takeuchi
Professor Emeritus, Former President
Tokyo University of Marine Science and Technology

Shin-ichi Uye
Special Appointment Professor
Graduate School of Integrated Sciences for Life, Hiroshima University

Yukio Yasui
Associate Professor
Faculty of Agriculture, Kagawa University

Yasuhiro Yoshikawa
Dean
Faculty of Veterinary Medicine, Okayama University of Science

Specialist

Kiwamu Minamisawa
Specially-appointed Professor
Graduate School of Life Sciences, Tohoku University

Hirokazu Toju
Associate Professor
Center for Ecological Research, Kyoto University

(alphabetical order, titles as of April 1, 2022)

Eligible Fields for the 2023 Japan Prize

Areas of Physics, Chemistry, Informatics, and Engineering

Electronics, Information, and Communication

Background and Rationale:

The widespread adoption of IoT is producing vast amounts of data which fuel AI, such as deep learning, with substantial advances. As a result, innovative systems have been created in a variety of fields, and the revitalization of economic activities and the evolution of academic studies have been brought about.
Further societal, economic and academic advancements are envisaged through the development of fundamental technologies, such as optical and wireless networks, information security, semiconductor devices, robotics, and quantum computers, and the innovative systems capable of integrating these fundamental technologies.

Such technologies could solve many of societal challenges that human society faces, including climate change, food problems, energy issues, health issues, educational problems, and more. These technologies are highly expected to contribute to attaining safer, more secure, and more sustainable societies.

Eligible Achievements

The 2023 Japan prize in the field of Electronics, Information, and Communication rewards significant breakthroughs in fundamental technologies and systems which have contributed to creating safer and sustainable society, increased resilience to natural disasters/infectious diseases, and creation of new industries. Novel fundamental technologies that will contribute to the future development of society will also be eligible.

Areas of Life Science, Agriculture, and Medicine

Life Sciences

Background and Rationale:

The life sciences seek to better comprehend the complex and subtle mechanisms underlying the activity of all living organisms. Since the mid-20th century, researchers in this field have made great strides by analyzing the function of genes and cells. Through high-speed analysis of genetic information and targeted genetic engineering in a variety of organisms and individual humans, and through improved imaging technologies to visualize the microstructure of cells and tissues, the life sciences are pioneering new approaches to improving our lives and maintaining our health. Playing a key role in controlling the global COVID-19 pandemic crisis, basic life-science knowledge built up over decades contributed to the astonishing speed at which novel vaccines were developed. The life sciences seek an ever deeper understanding of life through ever more advanced technologies, such as single-cell analysis, and new lines of enquiry into how epigenetics controls gene expression.

With due regard for bioethics, the search for a deeper understanding of biological phenomena will, we hope, generate new methods of medical treatment, inform sound judgment needed to ensure humanity's sustainable development, and contribute to people's well-being.

Eligible Achievements

The 2023 Japan Prize in the field of Life Sciences rewards significant contributions to society through discoveries of new biological phenomena and elucidation of biological regulatory mechanisms as well as major advances in scientific technology that make possible deeper understanding of biological functions.

Schedule (2023-2025)

The eligible fields for the Japan Prize (2023 to 2025) have been decided for the two research areas, respectively. These fields rotate every year in a three year cycle. Every year the Fields Selection Committee announces the eligible field for the next three years.

Areas of Physics, Chemistry, Informatics, and Engineering

Year	Eligible Fields
2023	Electronics, Information, and Communication
2024	Resources, Energy, Environment, and Social Infrastructure
2025	Materials and Production

Areas of Life Science, Agriculture, and Medicine

Year	Eligible Fields
2023	Life Science
2024	Medical Science and Medicinal Science
2025	Biological Production, Ecology/ Environment

2022

Field of Materials and Production

For pioneering research contributing to the development of mRNA vaccines

Prof. Katalin Karikó

Hungary/ USA　Born in 1955
Senior Vice President, BioNTech SE
Adjunct Professor, Perelman School of Medicine,
University of Pennsylvania
Professor, University of Szeged

Prof. Drew Weissman

USA　Born in 1959
Professor of Medicine,
University of Pennsylvania School of Medicine
Director Penn Institute for RNA Innovation

COVID-19 vaccinations began in the United States and United Kingdom ahead of the rest of the world in December 2020, and people in Japan also became eligible to receive the vaccines in February 2021. It was initially thought that it would take years to develop the vaccines, but mass production became possible in only around one year, thus saving many lives and stemming economic losses across the globe. The vaccines are now serving as a powerful tool in bringing the global pandemic to a close. These mRNA (or messenger-RNA) vaccines differ from conventional vaccines.

Like DNA, mRNA is a type of nucleic acid, and it serves as the blueprint for protein synthesis in the body. Research into medical applications for mRNA was conducted alongside research into DNA in the 1990s, but it was abandoned due to obstacles caused by undesired immune response.

However, in 2005, Professors Katalin Karikó and Drew Weissman discovered that by replacing the uridine in mRNA with a modified nucleic acid called pseudouridine, they could suppress that undesired immune response. Furthermore, in 2008, they announced that using pseudouridine allowed them to achieve their goal of increased protein production. These discoveries opened the doors to using mRNA in medical applications and made it possible for COVID-19 vaccines to be developed quickly.

Field of Biological Production, Ecology/Environment

For outstanding contributions to estimationof global biospheric productivity and climate change science using advanced formulas based on observation

Prof. Christopher Field

USA　Born in 1953
Director, Woods Institute for the Environment, Stanford University
Professor for Interdisciplinary Environmental Studies

Estimates based on the dynamics of the global biosphere are essential for accurate prediction of future climate change. Particularly important is to clarify what effect plants, which serve as sinks for carbon dioxide (CO2), have on climate change. Without an understanding of that, it is impossible to know how much the reduction of artificial CO2 emissions will help in stopping the progress of global warming.

Professor Christopher Field has spent much of his career accumulating data on living leaves through in-field observation, and he used that data to make it possible to express how the photosynthetic rate of leaves is dependent on the environment in which they grow. Moreover, he developed the equations that enable a plant ecosystem to be considered a single virtual leaf: the “Big-leaf Model.” He then integrated this with climate models, satellite observations, and oceanographic research to clarify the global distribution of CO2 absorption across both land and sea, and to identify the factors that affect CO_2 concentration in the atmosphere.

Field’s research has become the scientific basis for the climate change measures being implemented today through such initiatives as the Paris Agreement, an international framework for combatting global warming, and the Intergovernmental Panel on Climate Change (IPCC).

2021

Field of Resources, Energy, Environment, Social Infrastructure

Development of High-Efficiency Silicon Photovoltaic Devices

Prof. Martin Andrew Green

Australia　Born in 1948
Professor, University of New South Wales (UNSW Sydney)

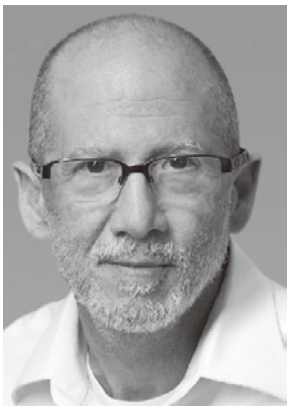
Prof. Martin Green has pioneered the development of high-efficiency silicon photovoltaic devices and contributed significantly to the realization of solar power that is now cheaper than fossil fuel power.

Especially, he made great achievements in increasing power conversion efficiency dramatically from around 17% to 25% by innovating advanced technologies and integrating them into practical devices that now make the transition to a low-carbon society realistic.

He has also trained the researchers and entrepreneurs who have played key roles in industrial development and in reducing the price of silicon photovoltaic devices.

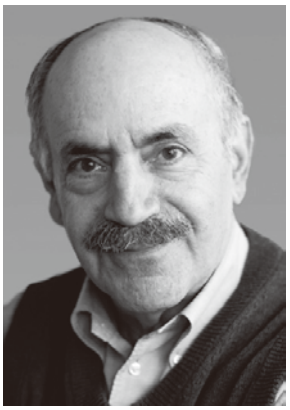
Field of Medical Science, Medicinal Science

For their pioneering work in conceptualizing a model of multi-step carcinogenesis and its application and impact on improving cancer diagnosis and therapeutics



Prof. Bert Vogelstein

USA　Born in 1949
Professor, Johns Hopkins University School of Medicine



Dr. Robert A. Weinberg

USA　Born in 1942
Member, Whitehead Institute for Biomedical Research
Professor, Massachusetts Institute of Technology (MIT)

In spite of improved survival rates, the grim fate of most diagnosed patients is to succumb to the disease or one of its associated comorbidities. Improved survival rates over the last several decades are, in part, the result of discovery of novel anti-cancer agents. The medical advancements underpinning discovery of novel therapeutics and improvements in access to care, and early detection were predicated on innumerable basic and clinical research findings that have elucidated the inner workings of cancer development and survival mechanisms. Understood as a general principle, cancer arises through the accumulation of genetic and epigenetic mutations and alterations that are favorable to the survival and expansion of the tumor cells. This concept has been termed “multi-step carcinogenesis model” and has served as a reliable and accepted foundation for subsequent oncological research. Many of the seminal studies underpinning the multi-step carcinogenesis model were the research discoveries made by Drs. Robert Weinberg and Bert Vogelstein.

2020

Field of Electronics, Information, Communication

Pioneering contribution to information and coding theory

Prof. Robert G. Gallager

USA Born in 1931

Professor Emeritus,

Massachusetts Institute of Technology

From general communication devices such as TVs, personal computers and mobile phones to cutting-edge researches utilizing big-data, such as particle physics and astronomy, digital information communication is one of the fundamental technologies that support today's society. However, when performing data communication, errors can occur due to external noise, and for many years, a lot of research was conducted on developing detection and correction schemes for such errors.

Among them, LDPC codes (Low-Density Parity-Check Codes), invented by Prof. Robert G. Gallager, is an extremely reliable and practical scheme.

Starting with its adoption in the fifth-generation mobile communication system (5G), LDPC codes are expected to support the coming generations of high-speed and large-capacity communications.

Field of Life Science

Pioneering contributions to paleoanthropology through decoding ancient human genome sequences

Dr. Svante Pääbo

Sweden Born in 1955

Director, Department of Evolutionary Genetics

Max Planck Institute for Evolutionary Anthropology

Where did we humans come from?

Elucidating "the origin and evolution of modern humans" is one of the biggest challenges in paleoanthropology. Traditionally, the evolution and classification of humans had been approached by analyzing the shape of excavated bone and teeth fossils. However, from the mid-1980s, Dr. Svante Pääbo adopted the "genetic approach", which involves extracting and analyzing DNA, and made series of discoveries that have enabled us to understand modern human evolution at much greater depth.

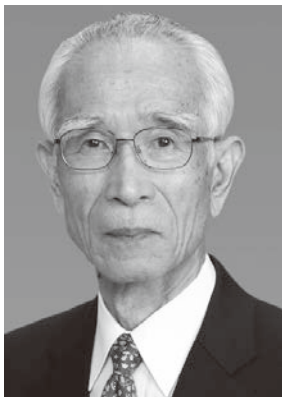
In particular, the DNA analysis of Neanderthals revealed that the ancestors of modern humans interbred with Neanderthals. Furthermore, the DNA from a fossilized bone fragment excavated from the Denisova cave in Russia revealed the existence of a previously unknown species of humans called the Denisovans.

By analyzing the DNA of ancient humans, Dr. Pääbo has shed new light on the fundamental question of where modern humans came from.

2019

Field of Materials and Production

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



Prof. Yoshio Okamoto

Japan　Born in 1941

University Professor of Nagoya University

Chair Professor of Harbin Engineering University China

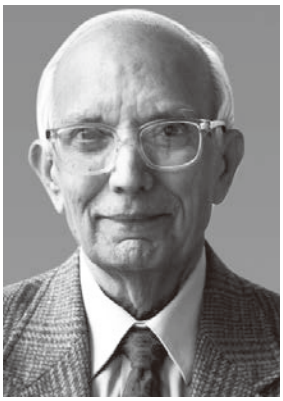
Even among two molecules of the same chemical composition, some have a three-dimensional structure with a mirror image that cannot be superimposed on to the other, as it is the case with our left and right hand. Such molecules are said to be in an enantiomeric relationship. Among enantiomers, physical properties such as the melting point and boiling point are the same, but their physiological effects on the human body can differ. This can cause major problems for the production of pharmaceuticals.

Despite the above being the case, ordinary chemical synthesis can only produce enantiomer mixtures. Along with the advancement of the technique for synthesizing only one hand of the molecule with a catalyst, the convenient method for separating the generated mixture has also come to be widely used. This was made possible by helical polymers. When one-handed helical polymer is coated onto silica gel, packed in a column and enantiomer mixture is injected through, the enantiomer that is more prone to being captured by the helical polymer remains in the column for a long period of time, and the other enantiomer that is less prone to being captured flows out first.

Prof. Yoshio Okamoto was the first in the world to achieve the synthesis of a one-handed helical polymer, and even demonstrated its utility in the separation of enantiomers. Today, products that have been derived from the application of these discoveries are being widely used throughout the world for the research & development and the manufacturing of pharmaceuticals, aroma chemicals and functional materials. Prof. Okamoto's achievements that span the advancement of basic polymer synthesis science to its practical application are highly regarded by the international community.

Field of Biological Production, Ecology

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



Prof. Rattan Lal

USA　Born in 1944

Distinguished University Professor of Soil Science

Director, Carbon Management and Sequestration Center

The Ohio State University

Soil is important not only for food production but also for a wide range of functions in environmental conservation, such as carbon sequestration, environmental cleanup, material circulation and preservation of biodiversity. Prof. Rattan Lal demonstrated in Africa's sub-Saharan region that the "no-tillage cultivation method" can ensure stable biological production while preventing soil erosion, and has undertaken great efforts to spread this technique and promote the idea that a healthy soil is the basis of sustainable agriculture and good environment.

While the soil is usually plowed in agriculture, the no-tillage cultivation method which does away with plowing was adapted and tested by Prof. Lal who had noticed the outflow mechanism of soil organic matter. Based on this finding, Prof. Lal began studying the relationship between soil and global environmental issues.

As a result of the analysis of the global carbon cycle, he found out that with appropriate management, soil not only isolates carbon and reduces CO2 in the atmosphere but also becomes fertile, thereby improving food production.

And as a result of his continuous appeal to the international community of the importance of appropriate soil management, Prof. Lal's ideas were formulated into the policy of international effort for soil preservation called the "4 per 1000 Initiative", and is closely tied to the promotion of the UN's Sustainable Development Goals (SDGs).

2018

Field of Resources, Energy, Environment and Social Infrastructure

Development of lithium ion batteries

Dr. Akira Yoshino

Japan　Born in 1948
Honorary Fellow, Asahi Kasei Corporation
Professor, Graduate School of Science and Technology, Meijo University

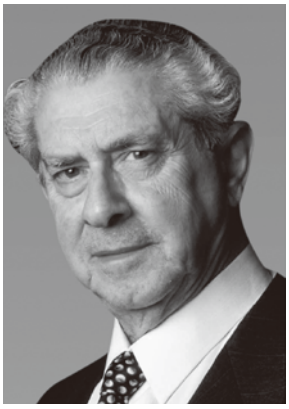
The lithium ion battery is a type of secondary battery capable of charge/discharge that has become the backbone of today's mobile society by powering smartphones and laptop PCs. It is also being adopted in electric vehicles that are becoming increasingly widespread, serving to reduce emissions of environment-impacting substances. In the early 1980s, Dr. Yoshino put forth the concept of the lithium ion battery and demonstrated its charge/discharge capability. At the time, research on batteries using lithium metal anodes was more predominant, with a strong focus on cathode materials and non-aqueous electrolyte solutions. Dr. Yoshino proposed and demonstrated a viable secondary battery using lithium cobalt oxide for the cathode and a carbon-based material for the anode, which he combined with his original separator and current collector technology. The resulting battery attained high voltage, high energy density, safety and a long-life. Lithium ion batteries have since continued to improve through constant refinements in materials and manufacturing methods, and their application is anticipated to grow into the future.

Field of Medical Science and Medicinal Science

Discovery of B and T lymphocyte lineages and its impact on understanding disease pathology and therapeutic development (Joint Award)

Dr. Max D. Cooper

USA　Born in 1933
Professor,
Emory University School of Medicine



Dr. Jacques Miller

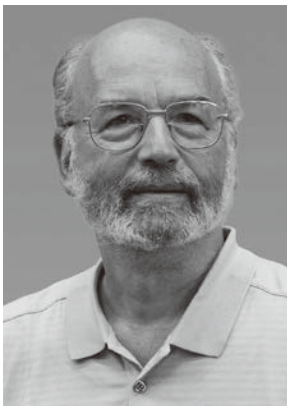
Australia　Born in 1931
Professor Emeritus, Walter and Eliza Hall Institute of Medical Research

Dr. Max D. Cooper and Dr. Jacques Miller discovered the "B and T lymphocytes", the two primary cell lineages involved in adaptive immunity that are responsible for protecting our bodies from intrusion by foreign substances. The B lymphocytes are responsible for the production of antibodies that attack foreign substances such as invading pathogens. T lymphocytes, on the other hand, are responsible for attacking virus-infected cells and cancer cells, and assisting B lymphocytes in the production of antibodies. Using mice, Dr. Miller discovered that T lymphocytes are produced by the thymus, which was considered a vestigial organ at the time. Dr. Cooper, on the other hand, hypothesized that there are two cell lineages with different functions in adaptive immunity and verified their existence through experiments on chickens. Their pioneering achievements laid the foundation for the next half century of developments in immunology from basic concepts to applied research. The development of new therapeutic drugs for cancers and immune disorders, which has been attracting much attention in recent years, would not have been possible without Dr. Cooper and Dr. Miller's discoveries.

2017

Field of Electronics, Information and Communication

Contribution to information security through pioneering research on cryptography



Dr. Adi Shamir

Israel　Born in 1952

Professor,

Weizmann Institute of Science

The advent of open digital networks, namely the Internet, has enabled us to lead a convenient lifestyle like never before. Such comfort has been made possible thanks to security measures preventing the theft and manipulation of valuable information. It is Dr. Adi Shamir who proposed many of the underlying concepts in information security and developed a series of practical solutions.

Information in digital networks is coded in binary digits. Utilizing mathematical methodology, Dr. Shamir has invented and proposed numerous techniques, such as the innovative " RSA cryptosystem," the "secret sharing scheme" which ensures secrecy by breaking up classified information into parts and dispersing it among several participants, the "identification scheme" with which individuals can be identified without revealing secret information and the generic "differential cryptanalysis" which deciphers many common key cryptosystems.

Dr. Shamir has also made a significant breakthrough in the research of side-channel attacks which decipher code by monitoring the physical information of the computer carrying out encryption, such as power consumption and noise.

Field of Life Science

Elucidation of the genome editing mechanism by the CRISPR-Cas (Joint Award)

Prof. Emmanuelle Charpentier

France　Born in 1968

Director,

Max Planck Institute

for Infection Biology (Berlin)

Dr. Jennifer A. Doudna

USA　Born in 1964

Professor,

University of California, Berkeley

Genome editing using the CRISPR-Cas system, announced by Prof. Emmanuelle Charpentier and Dr. Jennifer Doudna in 2012, is a revolutionary new technology in genetic engineering. It was adopted at an explosive rate as a useful tool for research in the life sciences. Today, it continues to be applied to research in a wide range of fields, such as breeding, drug development and medicine. This technology was developed in the process of elucidating the bacterial defense mechanism against such threats as viral infections. Bacteria can remember the DNA of intruding viruses by absorbing their DNA into their own. Upon the next infection, bacteria recognize the intruder's DNA and snips it with the RNA-guided CAS protein, thereby destroying intruding viruses. Genome editing by the CRISPR-Cas system takes advantage of this mechanism, and enables one to cut the DNA of any organism at arbitrary locations to edit freely by means of removing, replacing or insertion.

2016

Field of Materials and Production

Creation of unconventional inorganic materials with novel electronic functions based on nano-structure engineering

Dr. Hideo Hosono

Japan　Born in 1953

Laboratory for Materials and Structures,
Institute of Innovative Research, Tokyo Institute of Technology
Director, Materials Research Center of Element Strategy

Discovery of new materials is a major driving force that transforms industry and our society. Dr. Hideo Hosono endeavored to create new functional materials in areas where others had not yet achieved success. For example, it was said that " transparent oxides" like glass are unsuitable as electrofunctional material because of their electrical nonconductivity, but Dr. Hosono studied their nano-structure and developed the " transparent amorphous oxide semiconductor." Today, it is extensively used in technologies such as liquid crystal displays (LCDs) and organic light-emitting diode (OLED) displays, contributing enormously towards our society.

Furthermore, he has developed a series of unconventional inorganic materials with electronic functions. In the field of superconductivity research, he focused on iron compounds, which nobody had been paying attention to, and achieved high superconducting transition temperature. He also developed "electrically conductive cement" by modifying the nano-structure of what had been considered an archetypal insulator material.

Field of Biological Production and Biological Environment

Contribution to modern crop breeding through research on development of molecular genetic analysis

Dr. Steven D. Tanksley

USA　Born in 1954

Professor Emeritus,
Cornell University

Since the beginning of agriculture, mankind has practiced selective breeding in search of crops with enhanced traits. For most of that time, the methods practiced relied on experience and intuition. From the 1980s, however, rapid advancements in genomic analysis techniques brought about significant changes. The pioneering figure who continuously led this field was Dr. Steven Tanksley.

Dr. Tanksley created chromosomal maps of crops by molecular genetic analysis and went on to identify genes that are related to agricultural productivity, such as fruit size, thereby developing a genomic analysis technique that is instrumental for selective breeding. His research, which combines genetic information and breeding techniques, has contributed enormously to increasing selection accuracy and reducing the amount of time required to breed new crop varieties.

2015

Field of Resources, Energy and Social Infrastructure

Contribution to development of innovative concept on river basin management and reduction of water-related disasters

Dr. Yutaka Takahasi

Japan (1927 - 2021)

Professor Emeritus, University of Tokyo

We humans benefit from rivers in our day-to-day lives, but on occasion, suffer severe damage from bank collapse due to swelling river waters. Dr. Yutaka Takahasi has conducted field surveys and data analysis on post-war flood disasters, such as those caused by typhoons, and scientifically verified that transformations in river basins due to large-scale river improvements and developments from the Meiji Era onward have contributed to the magnification of the scale of floods. In addition, in order to reduce the scale of flood damage, he has continued to propose "integrated flood control measures," which aim not only to make river improvements such as the building of banks but also to achieve basin management through regulating reservoirs and the maintenance of a sound water cycle. Dr. Takahasi's proposal has also been applied to measures against flood disasters frequently occurring worldwide which have been attributed to global warming.

Field of Medical Science and Medicinal Science

Proposal of the concept of gene therapy and its clinical applications (Joint Award)

Dr. Theodore Friedmann

USA Born in 1935

Professor of Pediatrics, University of California San Diego, School of Medicine

Prof. Alain Fischer

France Born in 1949

Professor at Collège de France, Director of Institute Imagine, Hôpital Necker-Enfants malades

"Injecting genes or gene-transduced cells into a human body for the purpose of treating diseases" is called gene therapy. In the last few years, there has been a series of reports on convincing clinical efficacy of gene therapy in patients suffering from difficult-to-treat diseases, such as congenital diseases and intractable neurological diseases. The origin of gene therapy can be traced back about 40 years ago to 1972, when Dr. Theodore Friedmann published an article on the revolutionary therapeutic concept and research procedure in a scientific journal. In the years following that event, many researchers carried out fundamental research. Clinical studies started in 1990, but no convincing clinical efficacy could be established. After a period of trial and error, in 1999, Prof. Alain Fischer successfully implemented a hematopoietic stem cell gene therapy on patients with X-linked severe combined immunodeficiency disease with dramatic results, proving the efficacy of gene therapy. The vision of gene therapy as portrayed by Dr. Friedmann and the empirical study carried out by Prof. Fischer paved the way for the present gene therapy.

2014

Field of Electronics, Information and Communication

Pioneering research on semiconductor lasers for high-capacity, long-distance optical fiber communication

Dr. Yasuharu Suematsu

Japan Born in 1932
Honorary Professor,
Tokyo Institute of Technology

Optical communication network using optical fiber is the pillar of present information society. Dr. Suematsu, Honorary Professor of Tokyo Institute of Technology, has been undertaking the study of optical communication since the early 1960s, the dawn of the optical electronics age. Dr. Suematsu was also a forerunner in taking a "problem-solving approach" in research. In this approach, levels of performance required by society are projected first, and theory and experiments are combined to achieve the goal. In the early 1980s, Dr. Suematsu gave shape to his idea of dynamic single-mode laser, which emits light in the wavelength range where the minimum loss is achieved and has a stable wavelength even with high-speed light modulation when transmitting information. His research on semiconductor lasers has greatly contributed to the realization of a high-capacity, long-distance optical fiber communication.

Field of Life Science

Discovery of histone modifications as fundamental regulators of gene expression

Dr. C. David Allis

USA Born in 1951
Joy and Jack Fishman Professor,
The Rockefeller University

A human body consists of approximately 60 trillion cells, and most of them have the same genetic information in DNA (deoxyribonucleic acid). How can cells with the same DNA develop into many different types of cells to make up the different organs in the body with different forms and functions, such as skin, liver and cranial nerves? A biochemist from the U.S., Dr. Allis, tackled this question and discovered from his research in the 1990s that enzymes that chemically modify histones, proteins found in chromosomes, play a vital role in the regulation of gene activity. His findings have greatly contributed to the understanding of the generation mechanism in which an organism grows from a fertilized egg, as well as to the development of drugs to treat cancer related to abnormalities in histone modifications.

2013

Field of Materials and Production

Development of chemically amplified resist polymer materials for innovative semiconductor manufacturing process (Joint Award)

Prof. C. Grant Willson

USA Born in 1939
Professor of Chemistry
and Chemical Engineering
The University of Texas at Austin

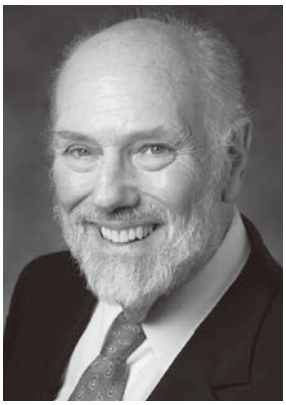
Prof. Jean M. J. Fréchet

USA Born in 1944
Vice-President for Research
King Abdullah University of Science
and Technology

The most important key technology which has been the driving force for innovation in semiconductor technology over the past half a century is lithography, which engraves fine circuits in semiconductors. Dr. Willson and Dr. Fréchet, along with the late Dr. Hiroshi Itoh, embarked on the development of the resist to be used for lithography in the early 1980's, and succeeded in developing a new key technology known as a chemically amplified resist. Through the use of resist developed jointly by the three doctors, a lithography using a short wavelength deep ultraviolet (deep UV; wavelength 254nm) was achieved. By improving this chemically amplified resist, an era of the next generation integrated circuit with a minimum semiconductor circuit width of under 250nm was opened up. The chemically amplified resist is an important technology for the extreme ultraviolet lithography (EUV; wavelength 1-10nm), a present leading edge technology, as well as for electron lithography, and is a key technology in creating new types of electronics.

Field of Biological Production and Biological Environment

Contribution to marine environmental conservation through research on ecology and biodiversity of deep-sea organisms



Dr. John Frederick Grassle

USA (1939 - 2018)
Professor Emeritus,
Rutgers, The State University of New Jersey

It has been thought for many years that only a limited number of living organisms exist in the deep sea exceeding a depth of 200m, due to the fact that hardly any sunlight, needed for photosynthesis, reaches there. However, in 1977, a hydrothermal vent called a black smoker was discovered at the bottom of the Pacific Ocean, and the existence of a wide variety of organisms was recorded. Marine Biologist Dr. Grassle organized an ecological survey mission using a manned research submersible, and clarified the existence of a chemosynthetic ecosystem in the deep ocean which utilizes not sunlight, but chemical substances supplied from the earth's interior.

Through his studies in the 1980's and the 1990's, Dr. Grassle proved that an abundant biodiversity exists in the deep sea comparable to that of the tropical rainforest. Furthermore, in 2000, a 10-year project which endeavors to shed light on the diversity, distribution and population of all marine life called " CoML: Census of Marine Life" was founded. The research findings thereof are greatly contributing to the preservation of the marine ecosystem which has rapidly been lost since the 20th Century.

2012

Field of Environment, Energy and Infrastructure

Developing the world's highest performing Nd-Fe-B type permanent magnet and contributing to energy conservation

Dr. Masato Sagawa

Japan Born in 1943

President, Intermetallics Co., Ltd.

One of the fundamental materials which support our highly industrialized society is a permanent magnet. In order to respond to the expectations for a stronger magnet, the Sm-Co(samarium-cobalt) magnet was developed in the 1960's. However, because cobalt was a rare resource, the scope of its application was limited. Amid such a climate, Dr. Sagawa embarked on the challenge of achieving a permanent magnet using iron, an abundant resource. Dr. Sagawa engaged in research and development of magnetic materials from a completely different perspective to the conventional. In 1982, he discovered the Nd-Fe-B (neodymium-iron-boron) magnet that has the world's largest energy product which breaks the Sm-Co magnet's record in the maximum energy product, and achieved the industrialization of this magnet. Motors which use neodymium magnets are compact, lightweight and highly efficient. Thus, they have greatly contributed to the solution of global environmental issues through power-saving industrial and household electronic products as well as through the high efficiency of new energy sources such as wind power generators.

Field of Healthcare and Medical Technology

Development of a new therapeutic drug targeting cancer-specific molecules (Joint Award)

Dr. Janet D. Rowley

USA (1925 - 2013)

Blum-Riese Distinguished Service Professor of Medicine, Molecular Genetics & Cell Biology and Human Genetics, The University of Chicago

Dr. Brian J. Druker

USA Born in 1955

Professor and Director of OHSU Knight Cancer Institute, Oregon Health & Science University

Dr. Nicholas B. Lydon

USA Born in 1957

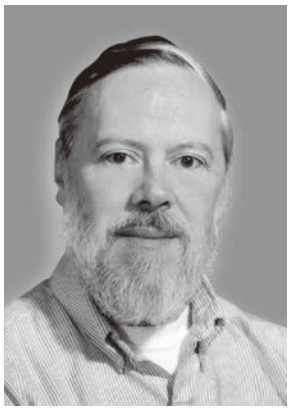
Founder and Director, Blueprint Medicines

Chronic myelogenous leukemia (CML) is a disease which is caused when a hematopoietic stem cell in the bone marrow turns cancerous. In 2001, with the introduction of the molecularly targeted drug imatinib, treatment results dramatically improved. The origin of imatinib began in 1973 when Dr. Rowley discovered that chromosomes 9 and 22 were recombined in the white blood cells of patients with CML. Dr. Druker and Dr. Lydon succeeded in developing a drug which suppressed the activity of the BCR-ABL protein which occurs as a result of the chromosomal recombination. At present, molecularly targeted drugs are indispensable to the treatment of cancer and autoimmune diseases, and the results obtained from the studies of Dr. Rowley, Dr. Druker and Dr. Lydon underscored the importance of developing molecularly targeted drugs, providing a guiding post for future research.

2011

Field of Information and Communications

Development of the operating system, UNIX (Joint Award)



Dr. Dennis M. Ritchie

USA (1941 - 2011)
Distinguished Member of Technical Staff Emeritus, Bell Labs

Dr. Ken L. Thompson

USA Born in 1943
Distinguished Engineer, Google Inc.

With present computer systems, basic software called operating systems are used in addition to application software to perform word processor, spreadsheet tasks, and so on. Dr. Ritchie and Dr. Thompson developed an advanced operating system called UNIX in 1969. The operating systems in those days were increasing in scale but becoming complex and disorderly. With UNIX, stability and high-speed performance could be attained by combining modularized programs. UNIX's superior design concept has been carried on by many computer technicians, and has supported the development of an advanced information society including the Internet.

Field of Bioscience and Medical Science

Discovery of interleukin-6 and its application in treating diseases (Joint Award)

Dr. Tadamitsu Kishimoto

Japan Born in 1939
Emeritus Professor, Osaka University

Dr. Toshio Hirano

Japan Born in 1947
Professor, Osaka University

Our bodies detect external invasions of bacteria and viruses and eliminate them. This mechanism is called "immunity." Immunity is a complex system consisting of various cells such as lymphocytes (T-cells, B-cells) and macrophage, but the substance which plays an important role in transmitting information between cells is called interleukin. Dr. Kishimoto and Dr. Hirano have purified interleukin 6 (IL-6), which plays a vital part in the production of antibodies, and also succeeded in gene cloning in 1986. In addition, the two doctors have identified a wide range of functions of IL-6 and their research results have contributed to the progress of bioscience and the development of therapeutic drugs for inflammatory diseases.

2010

Field of Industrial Production and Production Technology

Contributions to high-density magnetic recording technology by the development of a perpendicular magnetic recording method

Prof. Shun-ichi Iwasaki

Japan Born in 1926

Director, Tohoku Institute of Technology

Professor Emeritus, Tohoku University

LSI (large-scale integration) and the HDD (hard disk drive) which records information have played major roles in the progress of computer technology in the 20th century. It is not an exaggeration to say that the miniaturization and the increasing capacity of the HDD have created the information society through the Internet. Furthermore, what is giving behind-the-scenes support to the attainment of the next-generation system such as cloud computing is the ever-increasing capacity of the HDD by means of the perpendicular magnetic recording method. Prof. Iwasaki, through inspiration from the research of the magnetic recording principle, has developed the perpendicular magnetic recording method, which is more advantageous in attaining higher capacity in comparison to the conventional horizontal magnetic recording method. Since he advocated this method to the world in 1977, he has continued research and development for the practical application thereof.

Field of Biological Production and Environment

Contributions to solving global environmental issues based on the analysis of nitrogen and other substances' cycles

Prof. Peter Vitousek

USA Born in 1949

Professor of Biology, Stanford University

Since the Industrial Revolution, human economic activities have continued to expand, making the earth a relatively smaller place. Prof. Vitousek, an expert in ecosystems ecology, has been studying the material cycle of such nutrient elements as nitrogen and phosphorus in the ecosystem. Based on the aforementioned research, Prof. Vitousek has made pioneering achievements in the field of "biogeochemistry," which analyzes how various factors influence the ecosystem. From his achievements, he has pointed out the serious effects human activities have on the global environment as well as potential solutions for solving global environmental issues.

2009

Field of Transformation towards a Sustainable Society in Harmony with Nature

Contribution towards a sustainable world as founded in the 1972 Report titled 'The Limits to Growth'

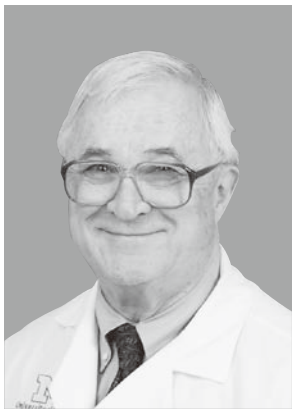
Dr. Dennis L. Meadows

USA Born in 1942
Professor Emeritus of Systems Policy,
University of New Hampshire
President, Laboratory for Interactive Learning

For humanity, the Earth is both irreplaceable and finite. The continued survival of humanity on Earth depends on its success in creating a "sustainable society." More than 30 years ago, Dr. Meadows was at the center of a research group that used scientific analysis to make this point. "The Limits to Growth" shocked the world when first published in 1972, and it continues even today to illuminate the way forward.

Field of Technological Integration of Medical Science and Engineering

Contribution to tomographic imaging in nuclear medicine



Dr. David E. Kuhl

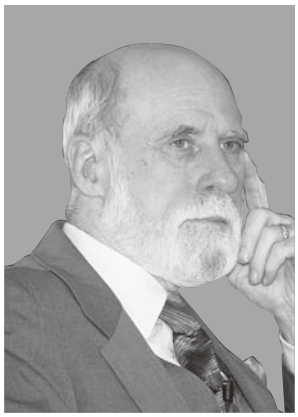
USA (1929 - 2017)
Professor, Radiology,
University of Michigan Medical School

Today various types of diagnostic imaging systems including CT (computed tomography) are used on a daily basis in hospitals and clinics all over the world. Dr. Kuhl, one of the world pioneers in tomography, began experimenting in the late 1950s by taking cross-sectional images of the distribution of radioisotopes in the body. He went on to develop SPECT (single photon emission computed tomography) in the late 1960s and succeeded in producing the world's first tomographic images of the human body. In addition to having a profound impact on the subsequent development of X-ray CT scanning and MRI (magnetic resonance imaging), Dr. Kuhl's research brought about the realization of PET (positron emission tomography), which is proving to be invaluable in the early detection of cancers.

2008

Field of Information Communication Theory and Technology

Creation of network architecture and communication protocol for the Internet (Joint Award)



Dr. Vinton G.Cerf

USA Born in 1943
Vice President and Chief Internet Evangelist, Google Inc.

Dr. Robert E.Kahn

USA Born in 1938
Chairman, CEO & President of Corporation for National Research Initiatives

The appearance of the Internet has pioneered the way for the establishment of a network society that has completely transformed the lifestyles of people around the world. Two men in particular were instrumental in the creation of the concept for the basic framework and the TCP/IP communication protocol which has made the Internet possible. These men are Dr. Cerf and Dr. Kahn. Known as the "Fathers of the Internet," Dr. Cerf and Dr. Kahn continue to lead advances in information communication.

Field of Medical Genomics and Genetics

Establishment of medical genetics and contributions to its development

Dr. Victor A. McKusick

USA (1921 - 2008)
University Professor of Medical Genetics, the McKusick- Nathans Institute of Genetic Medicine at the Johns Hopkins University

With the completion of the human genome project, we have come to understand almost all of the genetic information contained in DNA, which is encoded in a series of letters. However, we are still some way from fully identifying those parts which are related to the treatment of diseases. Dr. McKusick, has spent over half a century compiling related knowledge, and advocating the importance of the formulation of a genomic map for genetic disorders. Today, researchers and clinicians around the world are sharing the fruits of Dr. McKusick's labors which have become indispensable to the world of genetic medicine.

2007

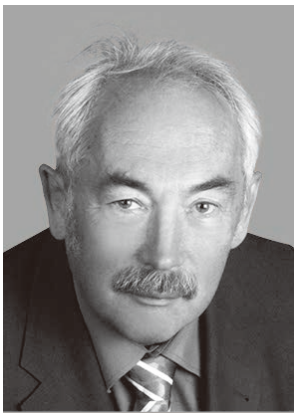
Field of Innovative Devices Inspired by Basic Research

The discovery of Giant Magneto-Resistance(GMR) and its contribution to development of innovative spin-electronics devices (Joint Award)

Prof. Albert Fert

France　Born in 1938

University of Paris-South



Prof. Dr. Peter Grünberg

Germany　(1939 - 2018)

The Research Center of Solid State Physics

Computer hard discs, which store vast amounts of memory, are improving year by year and at a faster rate than ever before. Now, however, these memory storage discs are not limited to computers, but are also being used in such electronic appliances as mobile music devices and video cameras. The reason behind the great increases in memory storage capacity and the rapidly diversifying use of hard discs is the discovery of Giant Magneto-Resistance (GMR), a groundbreaking technological innovation. The researchers responsible for this astonishing discovery are Prof. Fert and Prof. Dr. Grünberg.

Field of Science and Technology of Harmonious Co-Existence

Contribution to the conservation of tropical forest

Dr. Peter Shaw Ashton

UK　Born in 1934

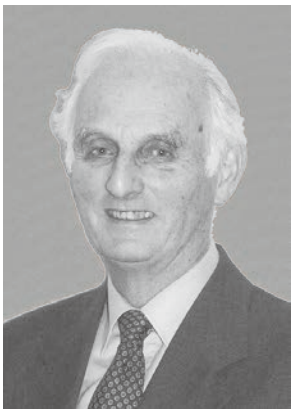
Charles Bullard Professor of Forestry

In recent times, the destruction of tropical forests has been progressing at an alarming rate. Tropical forests are a veritable treasury of a diverse array of many forms of life, and it is widely believed that the loss of this environment would have a major impact on the ecosystem of the entire planet. Dr. Ashton was awarded the 2007 Japan Prize in the category of “Science and Technology of Harmonious Co-Existence” for his extensive research into the phylogenetic systemization of flora and ecological studies in the tropical forests of Southeast Asia, and the contribution his findings have made to tropical conservation efforts.

2006

Field of Global Change

For pioneeering research on atmospheric structure and composition based on his satellite observation technology and for promotion of international assessments of climate change.



Sir John Houghton

UK (1931 ~ 2020)

Honorary Scientist, Hadley Centre for Climate Prediction and Research and Formerly Chief Executive, Meteorological Office, U.K.

Observations by weather satellites began in the 1970s. When Sir John Houghton developed a new means for making observations to measure the temperatures and composition of the upper atmosphere based on his independent theory. This opened the way to elucidating the three-dimensional temperature structure of, and distribution of micro-components such as ozone in the atmosphere across the entire globe. Then he established the Hadley Centre for Climate Prediction and Research to pursue this research and to study international climate change. He also has played a central role in compiling the First, Second and Third Assessment Reports under the auspices of the Intergovernmental Panel on Climate Change (IPCC).

Field of The Development of Novel Therapeutic Concepts and Technologies

The discovery of the statins and their development

Dr. Akira Endo

Japan Born in 1933

Director, Biopharm Research Laboratories, Inc., Tokyo, Japan

In 1973 Dr. Endo isolated from penicillium a ground-breaking substance called ML-236B (currently known as compactin) that lowers blood cholesterol levels, and confirmed that it was also effective in humans. This discovery triggered world-wide research into the compactin group and resulted in the birth of several hypercholesteremia drugs from amongst that group. These drugs, known collectively as statins, are presently used by approximately thirty million people around the world and help to prevent cardiac disease and strokes and so on.

2005

Field of Information and Media Technology

Pioneering contributions to natural language processing and intelligent image processing

Dr. Makoto Nagao

Japan (1936 - 2021)
President, National Institute of Information and Communications Technology

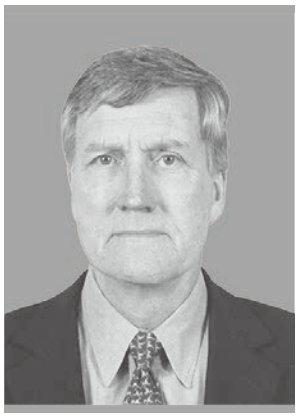
Dr. Nagao has pioneered research in the fields of machine translation, natural language processing, and image processing, and has achieved extensive results that have had a significant impact on other researchers in this field. Notably, he developed a fully functional Japanese-to-English / English-to-Japanese translation system, and was the world's first advocate of example based translation in machine translation. In image processing, he was the first to introduce feedback analysis mechanisms, which had a dramatic impact on many later research activities. He developed the world's first digital library prototype system incorporating natural language processing and image processing technologies, and has contributed to the new digital library era. In addition to being a pioneer, Dr. Nagao has been a leader in this field as well, for example as a founder of the International Association for Machine Translation and The Association for Natural Language Processing.

Field of Cell Biology

Fundamental contribution in elucidating the molecular mechanisms of cell adhesion (Joint Award)

Dr. Masatoshi Takeichi

Japan Born in 1943
Director of RIKEN Center for Developmental Biology



Dr. Erkki Ruoslahti

USA Born in 1940
Distinguished Professor, The Burnham Institute

Cell adhesion is fundamentally important in the construction of tissues and organs. Dr. Takeichi and Dr. Ruoslahti pinpointed the essential core processes in the complex phenomena of cell adhesion and succeeded in elucidating the mechanisms at the molecular level. Their accomplishments are expected to fundamentally contribute to working out the etiology and developing therapy of serious diseases such as malignant tumors.

2004

Field of Chemical Technology for the Environment

Pioneering work on photochemical catalysis and its application for the environment (Joint Award)

Dr. Kenichi Honda

Japan (1925 - 2011)
Professor Emeritus,
The University of Tokyo

Dr. Akira Fujishima

Japan Born in 1942
Chairman, Kanagawa Academy of Science and Technology

Dr. Honda and Dr. Fujishima found that irradiation of solar light onto a single crystal titanium dioxide (TiO_2) electrode resulted in the splitting of water into hydrogen and oxygen (The Honda-Fujishima effect). Thus, they pioneered research on artificial photosynthesis and production of hydrogen as a clean energy from water by using solar light. Furthermore, the development of the self-cleaning coatings of TiO_2 on a variety of surfaces is going to produce a new industry of photocatalysts, which significantly contributes to environmental conservation. The contributions of these two scientists to "Chemical Technology for the Environment" for the sustainable development of society are enormous.

Field of Food Production Based on Ecosystem Concepts

Contributions to the understanding of shelf ecosystems and their sustainable utilization

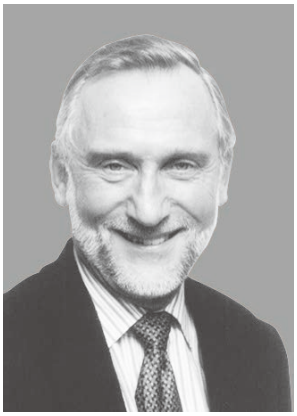
Dr. Keith J. Sainsbury

New Zealand Born in 1951
Senior Principal Research Scientist,
Division of Marine Research,
Commonwealth Scientific
and Industrial Research Organization

Dr. Sainsbury greatly contributed to the establishment of marine bio-resource management strategies for sustainable fishery production based on his basic studies on population dynamics including experimental fishery management mainly of demersal fish resources in the shelf ecosystem and consequently to the planning of the Australian marine policy. He also contributed much to the development of a paradigm for sustainable utilization of fishery resources in tropical and temperate marine areas.

Field of Science and Technology for Conservation of Biodiversity

Observational, experimental and theoretical achievements for the scientific understanding and conservation of biodiversity



Prof. John H. Lawton

UK Born in 1943
Chief Executive,
Natural Environment Research Council

Prof. Lawton is a prolific contributor to fundamental research on the ecological aspect of biodiversity. He studied various organisms, including birds, mammals, insects, and plants. He analyzed various species of these groups and the ways in which they co-exist with other species. Based on conservation, biological observation and analysis, he also contributed to the protection of bird species, actually serving as a key person in environmental NGOs.

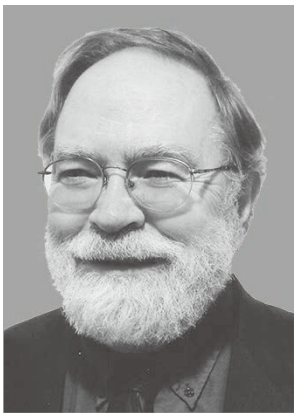
2003

Field of Science and Technology of Complexity

Creation of universal concepts in complex systems - chaos and fractals (Joint Award)

Dr. Benoit B. Mandelbrot

USA (1924 - 2010)
Sterling Professor of Mathematical Sciences, Mathematics Department, Yale University
IBM Fellow Emeritus, TJ Watson Research Center, International Business Machines Corporation



Dr. James A. Yorke

USA Born in 1941
Distinguished University Professor of Mathematics and Physics, Institute for Physical Sciences and Technology, University of Maryland

The world we live in is so complex that it is an enormous challenge to understand the fundamental nature of its complexities. Nature is filled with complex geometrical shapes. Dr. Mandelbrot discovered that “self-similarity”is the universal property that underlies such complex shapes, and he coined the expression “fractal.”

Many different, variable complex patterns of behavior are found in dynamic phenomena, Dr. Yorke found the universal mechanism underlying such nonlinear dynamic phenomena and summed it up using the term “chaos.”

The two concepts, chaos and fractals, have been established as universal concepts underlying such phenomena. Dr. Mandelbrot and Dr. Yorke utilized, respectively, the terms fractal and chaos and elucidated their fundamental properties. They have provided new frameworks for understanding complex phenomena, and have defined both their foundations and their applications.

Field of Visualizing Techniques in Medicine

Discovery of the principle for functional magnetic resonance imaging

Dr. Seiji Ogawa

Japan Born in 1934
Director, Ogawa Laboratories for Brain Function Research, Hamano Life Science Research Foundation

Dr. Ogawa discovered the principle upon which the field of functional and physiological imaging of the human body, particularly the human brain, is based. He searched for physiologically dependent signals in magnetic resonance imaging (MRI), and found BOLD (Blood Oxygenation Level Dependent) signal contrast in MR images of the brain, This work has proved to be the fundamental basis of noninvasive functional imaging methodology that is now widely used not only in many biological and medical sciences, such as neurobiology, psychology and neurology, but also in many fields of clinical medicine as diagnostic tools.

2002

Field of Computing and Computational Science and Engineering

Advancement of civilization through invention, implementation and deployment of the world wide web

Dr. Timothy John Berners-Lee

UK Born in 1955
Senior Research Scientist,
Laboratory for Computer Science, M.I.T.

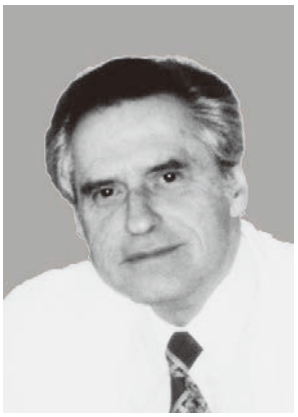
Dr. Berners-Lee is the inventor of the World Wide Web (www). Through his invention people were able to acquire information and work together by combining their knowledge in a web using hypertext documents through the Internet. He implemented the first www using HTML, Hypertext Markup Language developed by himself. The www has made revolutionary change in information exchange and communication among people, contributing to the globalization of information and communication in the world. It has created new forms of commercial and industrial activities like E-commerce, internet publications of newspapers and books, and more. The World Wide Web has made a profound and farreaching contribution not only to science and technology but also to the advancement of the civilization.

Field of Developmental Biology

Pioneering work on mammalian embryonic development (Joint Award)

Dr. Anne McLaren

UK (1927 - 2007)
Principal Research Associate,
Wellcome Trust / CRC Institute



Dr. Andrzej K. Tarkowski

Poland (1933 - 2016)
Director of the Institute of Zoology,
Warsaw University

Drs. McLaren and Tarkowski pioneered the developmental biology of mammals using a mouse as a model and established technologies to manipulate early embryos. Taking advantage of chimeric embryos in particular, they demonstrated the enormous plasticity of early embryonic cells, and gave deep insight into fundamental questions on mammalian embryonic development, such as how sexes differentiate, how genetic information of sexually distinct parents differentially contributes to development, and how cells interact in developing tissues. This work has proved fundamental as regards major issues not only of current developmental biology which are of increasing importance, but also for the progress of basic medical and veterinary sciences.

2001

Field of Science and Technology of Environment Conscious Materials

Discovery of environmentally benign electrode materials for high energy density rechargeable lithium batteries

Dr. John B. Goodenough

USA Born in 1922

Professor, University of Texas

Dr. Goodenouth recorded notable achievements in the field of solid-state science and made a great contribution to fundamental science. His well-known studies are on magnetism and the conductivity of transition metal compounds and on superionic conductors. Based on these research results and with profound insights, he found electrode materials for high-performance lithium batteries and used these materials to develop high-capacity portable rechargeable batteries. These batteries are not only environmentally benign but also very effective in the reduction of carbon dioxide emission.

Field of Marine Biology

Contribution to the development of biological / fisheries oceanography and for conservation of fishery resources and marine environment

Dr. Timothy R. Parsons

Canada Born in 1932

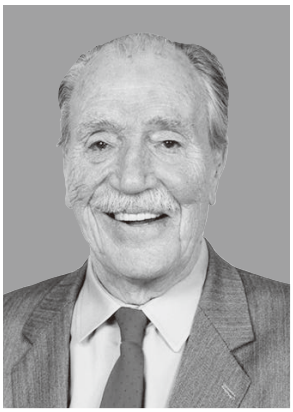
Professor Emeritus, University of British Columbia

Through his research devoted to obtaining a holistic understanding of how pelagic organisms are interconnected in the trophodynamic food-web of the sea, Dr. Parsons has made a great contribution to the development of Biological Oceanography as determined today. His goal has been to present an alternative method for the management of fisheries, based on measuring of dynamic relationships between fish and their physical, chemical and biological environments.

2000

Field of City Planning

Establishment of an ecological city planning process and proposal of a land use evaluation system



Prof. Ian L. McHarg

USA (1920 - 2001)
Professor Emeritus, Department of Landscape Architecture and Regional Planning, University of Pennsylvania.

Prof. McHarg introduced ecological ideas into city planning, visualized environmental ecosystems on overlay maps of factors such as physiography, hydrology, vegetation, and historical landmarks, and developed an innovative land use evaluation system, clarifying the suitability of, and restrictions on, land use. He is recognized as a founder of ecological planning, because of his distinguished achievements in the 1960s - when disorderly urban developments dominated - in ecological city planning, making the most of the abundant potential capabilities of nature. His methodology has had great influence upon city planning in an age when the global environment is of the utmost concern.

Field of Host Defense

Discovery of Immunoglobulin E and mechanisms of IgE-mediated allergic reactions

Dr. Kimishige Ishizaka

Japan (1925 - 2018)
President Emeritus, La Jolla Institute for Allergy and Immunology

Dr. Ishizaka was the first to discover immunoglobulin E and to elucidate fundamental mechanisms of allergic reaction at cellular and molecular levels. His work has profoundly influenced other medical research areas and even contributed to the clinical diagnosis and treatment of allergic diseases.

1999

Field of Information Technologies

Establishment of coding theory for reliable digital communication, broadcasting and storage

Dr. W. Wesley Peterson

USA (1924 - 2009)
Professor of Information and Computer Sciences,
University of Hawaii at Manoa

Dr. Peterson authored Error-Correcting Codes, the "bible" for the coding theory, and established the fundamentals of this field. He created the conceptual framework of coding theory on the basis of modern algebra and invented practical implementation methods for error detection and correction. This led to an exceptionally important contribution in the industrial application of error-correcting codes. Current digital communication, broadcasting and storage systems owe their reliability to his research results.

Field of Molecular Recognition and Dynamics in Bioscience

Elucidation of the three-dimensional structures of class I and class II human histocompatibility antigens and their bound peptides (Joint Award)

Dr. Jack L. Strominger

USA Born in 1925
Higgins Professor of Biochmistry,
Harvard University.

Dr. Don C. Wiley

USA (1944 - 2001)
John L. Loeb Professor of
Biochemistry and Biophysics,
Harvard University.

Dr. Strominger and Dr. Wiley were the first to elucidate the three-dimensional structures of the human histocompatibility complex class I and class II molecules. Their work provided a detailed understanding of how peptides derived from processed foreign antigens and self proteins are presented to T lymphocytes for the initiation of an immune response. Their work also opened a wide vista for investigation of autoimmunity, transplantation rejection, tumor immunity and the response to foreign pathogens.

1998

Field of Generation and
Design of New Materials Creating Novel Functions

For the creation and realization of the concept of man-made superlattice crystals which lead to generation of new materials with useful applications

Dr. Leo Esaki

Japan Born in 1925
Former President, University of Tsukuba

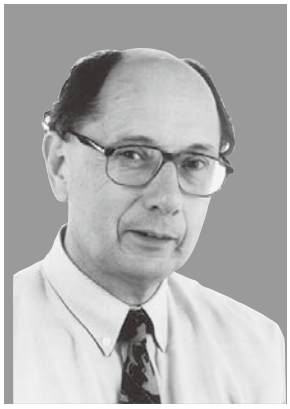
Dr. Esaki proposed the concept of "semiconductor superlattice," realized it, and discovered its peculiar properties such as negative differential conductivity and resonant tunneling. His concept of the superlattice inspired many other scientists. It underlies the high-speed transistor HEMT, optical devices with multiple-quantum wells, and giant magneto-resistance. "Superlattice" was a great accomplishment in terms of the generation and design of new materials to create novel functions. (Dr. Esaki was awarded with a Nobel Prize in Physics in 1973 for his discovery of tunneling in semiconductor p-n junctions. Superlattice is another great accomplishment he has made.)

Field of Biotechnology in Agricultural Sciences

Establishment of the theory and method of the production of transgenic plants (Joint Award)

Prof. Dr. Jozef S. Schell

Belgium (1935 - 2003)
Director, Department of Genetic Principles of Plant Breeding, Max-Planck-Institute für Züechtungsforschung, Germany



Dr. Marc C.E. Van Montagu

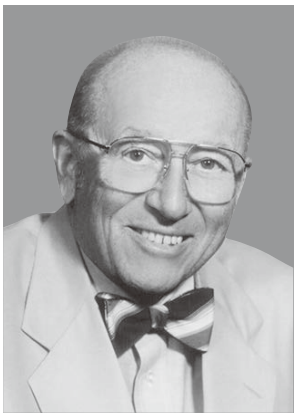
Belgium Born in 1933
Professor, Department of Genetics, University of Ghent, Belguim.

Dr. Schell and Dr. Van Montagu showed that the formation of tumors in plants with Agrobacterium is attributable to insertion of some genes contained in the bacteria into the nuclear genomes of host plants. They utilized this system to develop methods for efficient transfer of foreign genes into plant genomes. Recent advances in the production of transgenic plants have been based on their work.

1997

Field of Systems Engineering for an Artifactual Environment

Establishment of the robot industry and creation of a techno-global paradigm (Joint Award)



Dr. Joseph F. Engelberger

USA (1925 - 2015)
Chairman and Director,
HelpMate Robotics Inc.

Dr. Hiroyuki Yoshikawa

Japan Born in 1933
Former President,
The University of Tokyo

Dr. Engelberger foresaw from the beginning that machines called robots would markedly improve productivity and was a key person in their development and introduction for practical purposes. He has greatly contributed to the long-term expansion and development of the world economy by innovatively improving productivity in the manufacturing industry.

Dr. Yoshikawa has shown that the professional disciplines associated with the production of artifacts have been too specialized with respect to the system of knowledge, which has made the solving of such problems as environmental destruction and depletion of resources difficult.

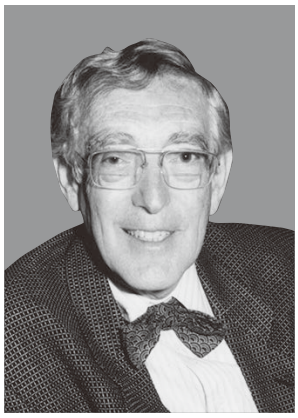
He has played a leading role in research in systematizing knowledge related to design and manufacturing and has developed a new field called general design theory. Based on this concept, he has proposed artifactual engineering in order to solve the above problems.

Field of Biotechnology in Medicine

Contribution to establishment of fundamental concept on causes of cancer (Joint Award)

Dr. Takashi Sugimura

Japan Born in (1926 - 2020)
President Emeritus of
National Cancer Center and
President of Toho University



Dr. Bruce N. Ames

USA Born in 1928
Professor of Biochemistry
and Molecular Biology,
University of California, Berkeley

As early as 1957, Dr. Sugimura discovered the carcinogenicity of a mutagen, 4-nitroquinoline-1-oxide. In 1967, he successfully induced stomach cancer in rats by oral administration of a mutagen, N-methyl-N'-nitro-N-nitrosoguanidine. He subsequently established the fact that many carcinogens were mutagens. He successfully isolated and identified many carcinogens with a structure of heterocyclic amine from foods cooked under ordinary conditions. He further developed his studies to analyze multiple step carcinogenesis at molecular levels. He demonstrated that many environmental carcinogens could be identified by their mutagenicity. He has made crucial contributions to the establishment of the fundamental concept on causes of cancer.

Dr. Ames first established an efficient in vitro assay for mutagens using Salmonella in 1971. This "Ames test" has been used widely in research institutes, industries and regulatory agencies around the world for screening environmental carcinogens and mutagens. This test has also been used to study metabolisms of carcinogens and mutagens. He established the fact that many carcinogens were mutagens. He made further contributions to the understanding of endogenous oxygenradicals in carcinogenesis and to the understanding of the mechanisms involved in aging. He demonstrated the close relationship between mutagenicity and carcinogenicity. He has made crucial contributions to the establishment of the fundamental concept of causes of cancer.

1996

Field of Information, Computer and Communication Systems

For pioneering research on wide-band, low-loss optical fiber communications

Dr. Charles K. Kao

USA (1933 - 2018)

Vice-Chancellor and President,
The Chinese University of Hong Kong.

The research on optical communications, which is expected to bring forth extensive social innovation, substantially started in 1960 with the invention of the laser, followed by studies on light source, transmission line and photodetectors. Dr. Kao predicted in specific terms the possibility of realizing large capacity optical communications using optical fiber, at an earlier phase, based on his own reasoning for the applicability of optical fiber to the large capacity transmission, and estimation of possible transmission range on the basis of presupposed loss and tolerable photoelectric power level. He played pioneering and leading roles in the exploitation of optical fiber transmission lines and his works are clearly appreciated in the world as having exerted a significant impact on the subsequent development of optical communication technology.

Field of Neuroscience

Elucidation of the functional principles and neural mechanisms of the cerebellum

Dr. Masao Ito

Japan (1928 - 2018)

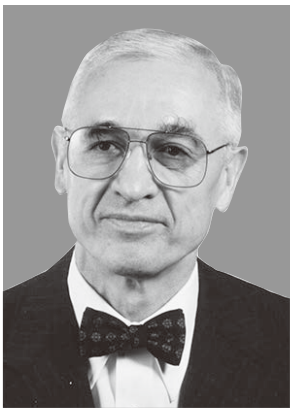
Director-General, Frontier Research Program,
The Institute of Physical and Chemical Research
President, Science Council of Japan

Dr. Ito has tried over 40 years to elucidate neural mechanisms of the brain by using a combination of neurophysiological, cell-biological, system-theoretical, and molecular biological approaches. In particular, he succesfully revealed several basic features of cerebellar function, such as inhibitory output of the Purkinje cells which is mediated γ-aminobutyric acid. He also found that the flocculus of the cerebellum plays a key role in adaptive control of the vestibule-ocular reflex, a basic reflex circuit, by way of a synaptic plasticity, the long-term depression, which is the basic of the learning capability of cerebellar cortical neural circuits. Furthermore, he and his collaborators elucidated molecular processes underlying long-term depression. They succeeded in inducing a reversible learning deficit by temporally inactivating long-term depression. The recent model he proposed aims at explaining a certain category of mental function, implicit memory, as function of the newest part of the cerebellum. His success gave a great impetus to researches in the neuroscience discipline.

1995

Field of Materials Processing Technologies

Outstanding contributions to research and practical applications of light emitting diodes and lasers through pioneering achievements in the understanding of physical principles and in the process technology of intermetallic compound semiconductors



Dr. Nick Holonyak, Jr.

USA Born in 1928

Professor, Center for Advanced Study,
John Bardeen Chair Professor, University of Illinois

Dr. Holonyak, focused his research on intermetallic compound semiconductors, which led him to the invention of the first practical light emitting diode (LED) by the use of GaAsP crystals. In 1962, he made the first visible light semiconductor laser.

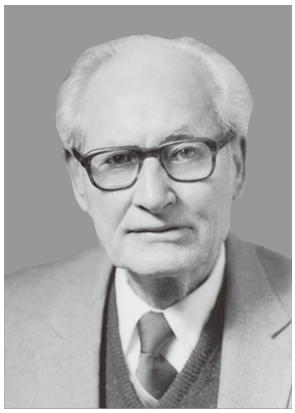
He extended his research to develop ternary and quaternary compound semiconductors, and was the first to succeed in independent control of the energy gap and lattice constant for preparing devices.

He was the first (1978) to achieve continuous room temperature operation of a laser with quantum-well-structure.

Dr. Holonyak's achievements ranging from research to practical developments on light-emitting diodes and lasers gave continuous stimulus and remarkable enrichment both to physics and technology.

Field of Science and Technology for Agriculture, Forestry and Fishery which conserves the Environment

Pioneer contributions in the development of integrated pest management by the sterile insect release method and other biological approaches



Dr. Edward F. Knipling

USA (1909 - 2000)

Retired Director,
Entomology Research Division, Agricultural Research Service

Dr. Knipling has devoted himself to the research on insect pest as a agricultural entomologist since 1931. He proposed the truly original idea of environmentally friendly pest control by suppressing the insect population in agricultural crops and domestic animals. Accordingly, he made outstanding contributions to the improvement of food production. He developed a new concept of insect pest control known as the sterile insect release method. In 1931 he attained great success in eradicating the screwworm fly, a serious and sometimes fatal pest of livestock in the Southwest region of the United States. From 1953, he made important contributions to the development of an environmentally sound method of insect pest control. He proposed and played a key role in promoting Integrated Pest Management. He played a leading role in scientific research and in application of his findings in terms of pest control without harming the environment.

1994

Field of Aerospace Technologies

Inspirational leadership in unmanned lunar and planetary exploration, and for pioneering achievements in the development of spacecraft and deep space communications

Dr. William Hayward Pickering

USA (1910 - 2004)

Professor Emeritus of the California Institute of Technology

Dr. Pickering, as a Director of the JPL, the California Institute of Technology, had made many pioneering contributions to space technologies such as the development of spacecraft as a means for space exploration, and the development of deep space communications network for data acquisition for 32 years. Owing to his command and guidance technologies, the USA's first artificial satellite "Explorer 1" was launched in 1958. And "Pioneer 4", the design of which was led by him, succeeded in becoming the first U.S. man made object to escape from the Earth's gravitational field in 1959. He developed new technologies for digital communications and high definition television. His achievements have made significant contributions to the "expansion of mankind's active domain to outer space". His technologies have been applied in many fields and have contributed to the welfare of mankind.

Field of Psychology and Psychiatry

Discovery of dopamine as a neurotransmitter and clarification of its role in mental and motor functions and their disorders

Dr. Arvid Carlsson

Sweden (1923 - 2018)

Professor Emeritus, Gothenburg University

Dr. Carlsson has made substantial contributions towards the clarification of the functions of dopamine in the brain. This has promoted causal treatment of Parkinson's disease. In 1988, he presented a modified hypothesis on schizophrenia. This showed a direction to understand schizophrenia as a putative transmitter imbalance syndrome and opened up new therapeutic strategies for Parkinson's disease. He has been an international leader in the field of neuropsychophamacology for three decades. His original and unique discoveries in dopamine research have led to a new understanding and new effective treatments for Schizophrenia and Parkinson's disease. He has made a great contribution to the development of psychology and psychiatry from the field of neuropsychopharmacology.

1993

Field of Safety Engineering and Disaster Mitigation

Development of modern seismology and advancement of international cooperation in disaster science

Dr. Frank Press

USA (1924 - 2020)

President of U.S. National Academy of Sciences

Dr. Press was the first to propose that the dispersion of long period eathquake surface wave motion could be used as a tool for studying the structure of the earth's crust and upper mantle. Analyzing surfaces waves, Dr. Press verified that the occurrence of an earthquake is fault motion itself. It was the beginning of modern seismology and the forerunner for studies on earthquake mechanisms.

Dr. Press was the leader in the promotion of scientific reseach and development in the area of disaster mitigation. As demonstrated by his efforts for International Geophysical Year (IGY) and Worldwide Standardized Seismograph Network (WWSSN), he recognized the importance of international cooperation in disaster sciences. He conceived and has been a leader in promoting the International Decade for Natural Disaster Reduction (IDNDR), a UN program in which the international community, under the auspices of the UN, will pay special attention during the last decade of the century to fostering international disaster (such as earthquakes, floods, droughts, volcanos, landslides, windstorms and wildfires) reduction.

Field of Molecular and Cellular Technology in Medicine

Development of the polymerase chain reaction

Dr. Kary B. Mullis

USA (1994 - 2019)

Founder and Vice President Research,
Atomic Tags, Inc.

The polymerase chain reaction (PCR) which was devised by Dr. Mullis, has revolutionized molecular genetics, molecular biology, medicine and many other related scientific fields. The PCR is a way of amplifying specific DNA sequences from small amounts of a complex template. Thus, in medicine the PCR has had a major impact on the diagnosis and screening of genetic diseases and cancer, the rapid detection of fatidious or slow growing microorganisms and viruses, the detection of minimal residual disease in leukemia. The method has also been applied to studies on molecular evolution. Analysis of DNAs from different human populations allowed the construction of phylogenetic trees. Samples of historic or ancient DNA from extinct species have successfully been subjected to PCR amplification. This capability of analyzing minute quantities of degraded DNA makes it possible to apply PCR for forensic purposes.

1992

Field of Science and Technology of Material Interfaces

Contributions to the new development of the chemistry and physics of solid surfaces

Prof. Dr. Gerhard Ertl

Germany Born in 1936
Director of Fritz-Haber Institute of Max Planck Society,
Honorary Professor at the Free University Berlin
and at the Technical University Berlin

Since the 1960s, Professor Ertl has developed extensive studies on the chemisorption phenomena of atoms or molecules of representative chemicals on metal surfaces, and has explained a number of important phenomena such as phase transitions in chemisorbed layers and the surface reconstruction induced by adsorption.

He has also pioneered and developed the study of the dynamical aspects of chemical processes on metal surfaces in atomic and molecular level.

By a series of outstanding scientific achievements in this area, he has opened up a new area of surface science, and made invaluable contributions to the development of this important and new research area in science and technology of material interfaces.

Field of Science and Technology for Biological Production

Discovery of method of the cryopreservation of semen and embryos in farm animals

Prof. Ernest John Christopher Polge

UK (1926 - 2006)
The Scientific Director
of Animal Biotechnology Cambridge Ltd.

Prof. Polge developed a new method for preservation of spermatozoa whereby bull semen in glycerol-containing media with-stood freezing at a very low temperature (-79˚C). This has promoted the growth of what has become a new science of cryobiology with practical applications in various spheres in medicine and agriculture. There is no doubt that the largest application has been in the deepfreezing of semen for artificial insemination, particularly in cattle; in which the impact on breeding and livestock improvement has been great. The development of techniques for the preservation of embryos at low temperatures is now being applied in a number of farm animal species.

1991

Field of Applied Mathematics

Contributions to analysis and control of distributed systems, and to promotion of applied analysis

Dr. Jacques-Louis Lions

France (1928 - 2001)
The Chairman of Analysis and
Systems Control at the Collège de France
and the President of National Center of Space Studies

Dr. Lions led the world to establish the new field of applied mathematics which makes good use of expertise inherited inside the traditional discipline of analysis and which can fully benefit from the powerful functions of modern computers.

His research and achievements have covered exceedingly wide areas, including establishment and development of the control theory of distributed systems which are governed by partial differential equations.

The method is expected to be the most promising among existing mathematical approaches to global and environmental problems.

As for applications in industry, Dr. Lions made considerable contributions to computational aerodynamics for the aerospace industry, simulation for the petroleum industry and mathematical analysis for the French Energy Agency.

Field of Imaging Techniques in Medicine

Development of ultrasound imaging in medicine

Dr. John Julian Wild

USA (1914 - 2009)
M.D., Ph.D., FAIUM, Head,
Physicomedical Institute, Minneapolis

In 1949, Dr. Wild manufactured prototype equipment for A-mode ultrasonography and with this equipment, he succeeded in measuring the thickness of the human colon. This was the first attempt to use ultrasound for biomedical application.

Subsequently, he developed a two-dimensional ultrasound image employing B-mode equipment, for which he has been also recognized as being the first pioneer of medical ultrasonic imaging. The method today is widely used on a variety of occasions including detection and diagnosis of brain tumors and breast cancer. In particular, the breast imaging by this equipment brought about the successful imaging of a tiny 7mm diameter nipple cancer.

1990

Field of Technology of Integration- Design, Production and Control Technologies

Establishment of an academic field named Artificial Intelligence and the proposal of fundamental theories in that field

Dr. Marvin Minsky

USA (1927 - 2016)

Professor of Electrical Engineering, MIT

Dr. Minsky published his paper "Steps Toward Artificial Intelligence" in 1961 and this gave Artificial Intelligence (AI) world wide exposure and has earned Dr. Minsky the title of "Father of AI". Artificial Intelligence became increasingly complex by the 1970s, involving vast amounts of knowledge and the need to use specially appropriate pieces of knowledge at particular times. Dr. Minsky proposed a theory of frames for the effective representation and utilization of knowledge in computers. In the 1980s, AI has produced many more practical application systems and many researchers have turned toward the question of how to make machines learn more by themselves. In addition to the development of the theory and practical application systems, he emphasized the necessity of study on the human mind including emotion and self consciousness. In his book "Society of Mind," he proposed a model of the human mind which consists of many small agents (computers) working together by communicating with each other. His proposal is expected to further expand the AI technology to other fields of science and help promote AI applications.

Field of Earth Science

Initiation of the theory of plate tectonics and contributions to its development (Joint Award)

Dr. William Jason Morgan

USA Born in 1935

Professor

at Princeton University

Dr. Dan Peter McKenzie

UK Born in 1942

Professor

at Cambridge University

Dr. Xavier Le Pichon

France Born in 1937

Directeur du

Département de Géologie,

Ecole Normale Supérieure

Dr. Morgan began his revolutionary work by dividing Earth's outer shell into some 20 plates, analyzing their movements as rigid, rotating segments of the shell, and measuring absolute velocities of plate motion. Mid-oceanic ridges, subduction zones and transform faults all came to be interpreted as results of the movements of these plates. The great significance of Dr. Morgan's theory became widely recognized and his work subsequently triggered numerous studies in a variety of fields.

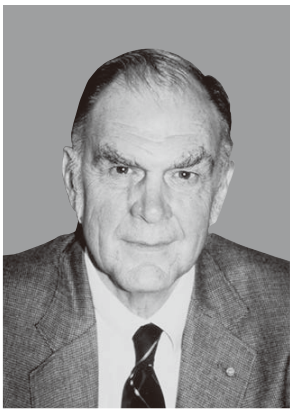
Dr. Mckenzie has analyzed earthquake systems in the circum-Pacific region and has demonstrated independently that the floor of the Pacific Ocean moves as a single plate, rotating against North America and East Asia. In collaboration with Dr. Morgan, Dr. Mckenzie has also carried out a geometrical analysis of triple junctions where three plates meet. This work has contributed greatly to understanding the relative motion of plates and the energetics of plate movements. He has also proposed the highly original model that large sedimentary basins, important in the formation of oil and natural gas deposits, are formed by thinning of the crust due to plate motion.

Dr. Le Pichon, inspired by the work of Dr. Morgan has independently determined plate movements over the entire surface of Earth, using ocean floor spreading velocities estimated from paleomagnetic patterns and the directions of transform faults. He has also published a book on plate tectonics which has had a great influence on Earth scientists throughout the world, and has played a major role in seafloor investigation at plate boundaries. Through these works, he has contributed greatly to the understanding of the geological nature of plate boundaries under the ocean.

1989

Field of Environmental Science and Technology

Studies on the mechanisms of stratospheric ozone depletion by chlorofluorocarbons



Dr. Frank Sherwood Rowland

USA (1927 - 2012)

Professor at University of California, Irvine

In 1974, Dr. Rowland, who studied physical chemistry, was the world's first scientist to point out the mechanisms by which chlorofluorocarbons could destroy the ozone layer which protects life on earth from harmful ultraviolet solar radiation.

He also predicted that if emission of chlorofluorocarbons continues at its current rate, it would eventually result in a 7-13% loss of the total ozone.

Dr. Rowland's theoretical insights and predictions have been verified by scientists throughout the world, and have done much to strengthen international efforts for the preservation of stratospheric ozone.

Field of Medicinal Science

Pioneering contributions to the syntheses of prostaglandins and their related compounds which are of great therapeutic value

Dr. Elias James Corey

USA Born in 1928

Professor at Harvard University

Dr. Corey's study covered almost all fields of organic chemistry. He became the first researcher to synthesize pure prostaglandins in natural, optically active form. This allowed the large scale production of all natural prostaglandins to provide a stable supply for other researchers, thus contributing considerably to the development of biochemistry and medicine.

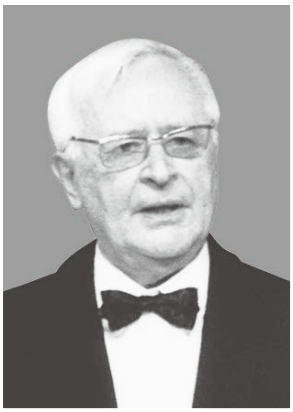
His synthesis had three major advantages over other methods in terms of efficiency, versatility, and economy.

Dr. Corey's achievement in the synthesis of eicosanoids is a monumental work in modern medicinal science. It is broadly expected that this synthesis will facilitate development of medicines for such diseases as cerebral thromboisis, arteriosclerosis and gastric and intestinal ulcers.

1988

Field of Energy Technology

Establishment of fast breeder reactor technology



Dr. Georges Vendryes

France (1920 - 2014)

Scientific advisor to the president of the Commissariat à l'Energie Atomique

Following his contribution to the establishment of the fundamentals of nuclear power design and the promotion of fast breeder reactor development, Dr. Vendryes' work led to the successful completion of "Super Phoenix," the world's first large-scale test breeder, establishing practical technologies for a solution to mankind's energy problem in the future.

Field of Preventative Medicine

Discovery of the AIDS causing virus and development of diagnostic methods (Joint Award)

Dr. Luc Montagnier

France (1932 - 2022)

Chief, Department of Virus Tumours, Pasteur Institute

Leading the joint research staff at the Pasteur Institute in 1983, Dr. Montagnier became the first researcher in the world to discover HIV, the pathogen behind AIDS, thus launching the start of genuine HIV research. He has also developed practical blood serum diagnostic methods for the establishment of basic preventative countermeasures.

Dr. Robert C. Gallo

USA Born in 1937

Chief, Laboratory of Tumour Cell Biology, National Institute of Health

Leading his own independent research group, Dr. Gallo established a method of culturing human T cells and succeeded in isolating the HIV virus, making a major contribution to analysis of its relationship with AIDS. He is also a pioneer in the research and development of AZT, the most effective AIDS treatment thus far, as well as in the effort to manifest a virus gene and realized and AIDS vaccine.

1988

Field of Preventative Medicine

The eradication of smallpox (Joint Award)

Dr. Donald A. Henderson

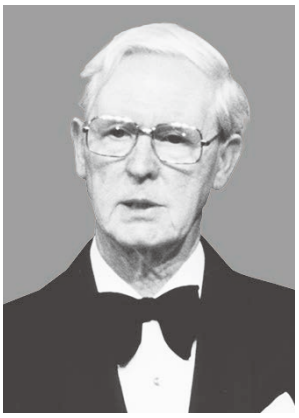
USA (1928 - 2016)
Dean, Johns Hopkins University,
School of Hygiene and Public Health

As the first chief medical officer of the WHO World Smallpox Eradication Office, Dr. Henderson dedicated his efforts to the development of group vaccination programs and contributed to its historic auccess through the worldwide eradication of smallpox.

Dr. Isao Arita

Japan Born in 1926
Director,
Kumamoto National Hospital

As the second chief medical officer of the WHO World Smallpox Eradication Office, Dr. Arita established basic disease control knowledge and performed epidemiological analysis as well as surveys and research into vaccine quality improvement.



Dr. Frank Fenner

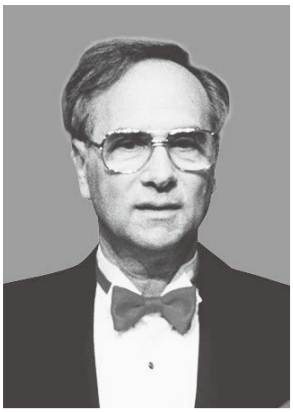
Australia (1914 - 2010)
Professor Emeritus,
Visiting Fellow, The John Curtin School of Medical Research,
The Australian National University

Dr. Fenner, as the chairman of the WHO Smallpox Eradication Surveillance Committee, supervised implementation of the global smallpox eradication program and his consistent efforts greatly contributed to its success.

1987

Field of Electro-Optics

Realization of the world's first laser



Dr. Theodore H. Maiman

USA (1927 - 2007)
Former chief of research at Hughes Research Laboratories
President of Maiman Associates Inc.

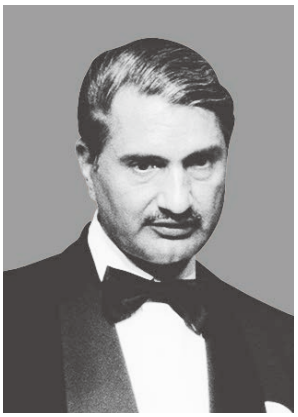
This pioneer in electro-optics became in 1960 the first scientist to succeed in generating radiation with a ruby laser, greatly aiding subsequent research on lasers. Dr. Maiman has also made a major contribution towards the advancement of the fields of natural science and engineering technology.

Field of Improvement of Biological Functions

Development of the IR8 and IR36 strains for rice breeding strategies geared to the tropical and subtropical zones (Joint Award)

Dr. Henry M. Beachell

USA (1906 - 2006)
Former head of the Plant Breeding Department at the International Rice Research Institute
Advisor to the Farms of Texas Company



Dr. Gurdev S. Khush

India Born In 1935
Head of the Plant Breeding Department at the International Rice Research Institute

Dr. Beachell has taken part in the IRRI's rice strain improvement projects since the institute's establishment. In 1966 he developed the IR8 strain that helped pave the way for the " green revolution" in developing nations.

Carrying on the work begun by Dr. Beachell, Dr. Khush further improved IR8 and in 1976 developed IR36, a strain highly tolerant of poor environmental conditions. IR36 contributed immensely to the attainment of production stability and self-sufficiency in rice in tropical and subtropical countries.

1986

Field of Materials Science and Technology

Pioneering contributions to materials science with impact on new materials technology such as amorphous solids

Dr. David Turnbull

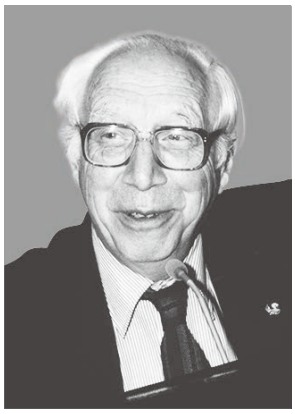
USA (1915 - 2007)

Professor at Harvard University

Dr. Turnbull, who formulated the guiding principles of new materials development, predicted what kinds of alloys will, like glass, tend to assume an amorphous character with an irregular alignment of atoms in rapid cooling from a molten state. In addition, this prominent scientist cleared the way for the production of high-density ceramics and perfect crystals for use in ICs.

Field of Medical Technology

Research and development of artificial organs and their relevant technology



Dr. Willem J. Kolff

USA (1911 - 2009)

Professor at the University of Utah.

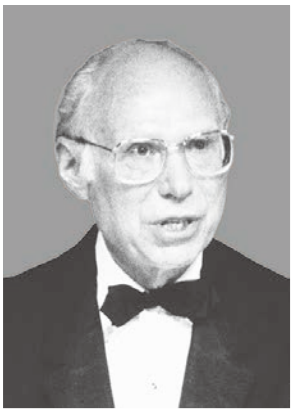
Head of the Institute for Biomedical Engineering.

As father of artificial organ technology, Dr. Kolff achieved clinical success in the development of a rotating drum-type kindney device in 1943. He then continued to work to popularize disposable-type artificial kidneys while playing a leading role in the development of artificial lungs and hearts.

1985

Field of Information and Communications

Outstanding achievement in the field of electronics and communications technologies



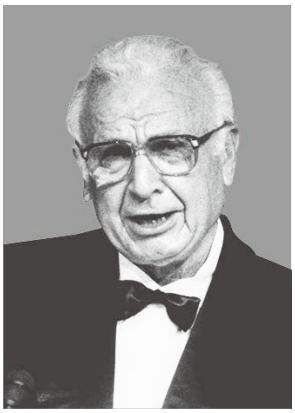
Dr. John R. Pierce

USA (1910 - 2002)
Professor Emeritus at Stanford University

Dr. Pierce's achievements in the field of information and telecommunication engineering represent the highest scientific caliber in the United States. His work has resulted in the theoretical development of the possibilities of communications satellites and of broad-band digital transmissions via pulse code modulations and multivalent signals.

Field of Biotechnology

Outstanding achievement in basic theory in the field of immobilized enzymes and their practical applications



Dr. Ephraim Katchalski-Katzir

Israel (1916 - 2009)
Professor at Tel Aviv University
and at Weiz-mann Institute of Science.

Dr. Katzir, the fourth President of the State of Israel from 1973 to 1978, is credited with the invention and development of the bioanalyzer and bioreactor, two devices employing immobilized enzymes and cells which form part of the foundation of biotechnology.

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