JAPAN PRIZE 2017

THE JAPAN PRIZE FOUNDATION

CONTENTS

Significance of the JAPAN PRIZE

Chairman
Hiroyuki Yoshikawa

Man is a species that has used wisdom to preserve its existence. In modern times, much of that wisdom has come to depend on knowledge derived from academic research. Nowadays, in particular, the rapid development of scientific and technical knowledge owes much to the endeavors of researchers and scientists. Research excellence is recognized through the award of various prizes, of which the Nobel Prize is one. We can say that the pedigree record of recipients reveals, not only to specialists but also to the general public, a history of the unique perspective that characterizes these prizes.

This being the case, what history should the Japan Prize reveal ? Considering that the overview of the Japan Prize refers to making concurrent contributions to the progress of science and to human peace and prosperity, it should reveal a history of both scientific and technological progress and a resultant history of peace and prosperity.

Looking back, it is simple to point out the overlapping existence of both of these. Even if, at some point in history, some aspect of science and technology exerted a negative outcome on mankind, over the longer course of time it is indisputable that scientific and technological advances have brought peace and prosperity to humanity.

Through the lineage record of its recipients, the Japan Prize speaks of a history that combines scientific and technological progress and human peace and prosperity. The Prize is not confined, however, to telling only of developments slowly revealed over the passage of time.

While respecting the various ways science and technology is currently unfolding, the prize endeavours to show history in progress based on a premise that the role of today's researcher is to create an overlapping history.

It is our sincerest wish that by reaching not just researchers but also the broader population the developments revealed will go on to ensure that science and technology make a substantial contribution to the peace and prosperity of humankind.

JAPAN PRIZE - Peace and prosperity for mankind

President
Yoshio Yazaki

Peace and prosperity for mankind is the common aspiration for all people of the world, and science and technology have played an immense role in this cause. Advancement in science and technology will no doubt continue to provide a powerful underpinning for the future peace and prosperity of the people.

The Japan Prize honors scientists and engineers from around the world whose original and outstanding achievements in science and technology are recognized as having advanced the frontiers of knowledge and served the cause of peace and prosperity.

Since the first presentation ceremony in 1985 to the 33rd ceremony to be held this year, 91 eminent scientists from 13 countries around the world have been awarded the prize.

When looking back over the history of the establishment of the Japan Prize, I can see that there was a strong desire to "express Japan's gratitude to international society". Because Japan, after World War II, wouldn't have developed into a modern nation so rapidly if it had not been for the wide range of scientific and technological knowledge it learned from abroad. Today, the strong enthusiasm of the first chairman and the initial members of this foundation continue to live on in our hearts.

In April every year, the Japan Prize presentation ceremony and the banquet are held in the presence of Their Majesties the Emperor and Empress of Japan, and are attended by representatives of the Three branches of the government as well as eminent persons from academic, governmental and political circles. It is a day when the laureates' outstanding achievements are honored and at the same time, an important day on which we wish for the unlimited advancement of science and technology.

The Japan Prize Foundation will continue to aspire for advancement in science and technology that contributes to the peace and prosperity of mankind by not only through the Japan Prize presentation but also through nurturing young scientists and engineers of tomorrow, and conducting promotional and educational activities in the field of science and technology.

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.
1987 The Foundation starts sending Japanese students to the annual Stockholm International Youth Science Seminar.
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".

JAPAN PRIZE

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."

Main Activities of the Foundation

The Japan Prize

The Japan Prize Foundation honors individuals whose original and outstanding achievements in science and technology are recognized as having advanced the frontiers of knowledge and served the cause of peace and prosperity for mankind.

Every year, the Foundation chooses two fields eligible for the prize, one each from the two areas of the "Physics, Chemistry and Engineering" and "Life Science, Agriculture and Medicine" and selects winners-one winner for each field in principle-after almost 10 months of fair and careful evaluation. Achievements of the candidates nominated by approximately 13,000 nominators in the world, prominent intellectuals, researchers and scientists selected by the Foundation, are assessed from both academic and social perspectives. The Foundation's Board of Directors wraps up the selection process by making the final decision on the candidates. The new Japan Prize laureates are announced each January.

Since 1985, 91 laureates from 13 countries have received the Japan Prize. Each laureate receives a certificate of merit and a commemorative medal. A cash prize of 50 million Japanese yen is also awarded in each prize category.

The Japan Prize Medal

The Japan Prize Presentation Ceremony

Research Grants

The Foundation provides research grants to scientists and researchers under 35 years of age. Every year, the Foundation selects projects in the same fields as the corresponding Japan Prize and gives one million Japanese yen for a project. In 2015, studies in "Clean & Sustainable Energy" were added as an eligible field of study to the two fields designated for the 2015 Japan Prize. The Foundation awarded research grants to 227 young scientists since the program's inception in 2006.

"Easy-to-Understand Science and Technology Seminars"

For junior and senior high school students, the Foundation holds a series of seminars on advanced technologies commonly used in everyday life by inviting Research Grant recipients as lecturers. They explain state-of-the-art technologies in plain terms. The program began in March 1989 and has since executed 295 seminars across Japan by the end of 2014.

Stockholm International Youth Science Seminar (SIYSS)

Each year, the Japan Prize Foundation provides an opportunity for young scientists to exchange opinions with their peers on an international level by sending two students to the Stockholm International Youth Science Seminar hosted by the Swedish Federation of Young scientists with the support of the Nobel Foundation. Young scientists from Japan and elsewhere in the world attend various events during Nobel Week in Stockholm. Since the program started in 1987, the Japan Prize Foundation has provided this valuable opportunity to 60 undergraduate/ graduate students.

THE JAPAN PRIZE

Background of Establishment

The Japan Prize Preparatory Foundation was established on November 1, 1982, with the approval of the Prime Minister, for the purpose of establishing the Japan Prize as a prestigious international award in the fields of science and technology.

The creation of the Japan Prize was motivated by the desire to "express Japan's gratitude to international society." This plan was advocated in 1981 by Dr. Taro Nakayama, the then Director General, the Prime Minister's Office of the Suzuki Cabinet, and supported with the fund donated by the late Mr. Konosuke Matsushita, the founder of Panasonic Corporation.

The Government issued the following cabinet endorsement on the establishment of the Japan Prize on October 28 1983.

Establishment of the Japan Prize

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)

* now renamed as The Japan Prize Foundation

Lifelong Ambition

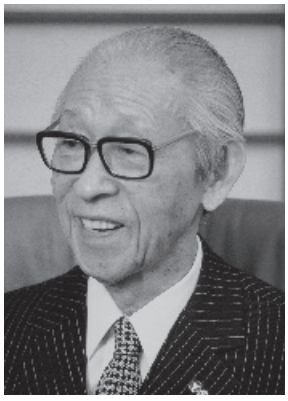
Peace and prosperity for mankind have been my lifelong desires. I am extremely pleased, therefore, that the Japan Prize has been established with the specific goal of making some contribution on behalf of Japan to the development of international society.

The progress of modern science and technology has been phenomenal. It is not overstating its role to say that we owe the civilization we enjoy today to this very progress.

On the other hand, there are still many global problems which remain to be solved, and the necessity to seek the counsel of many people is greater than ever before.

Under such circumstances, it is appropriate that Japan, in consultation with the international community, honors those who have produced outstanding achievements in the fields of science and technology.

It is my sincere hope that the Japan Prize achieves the recognition it deserves.

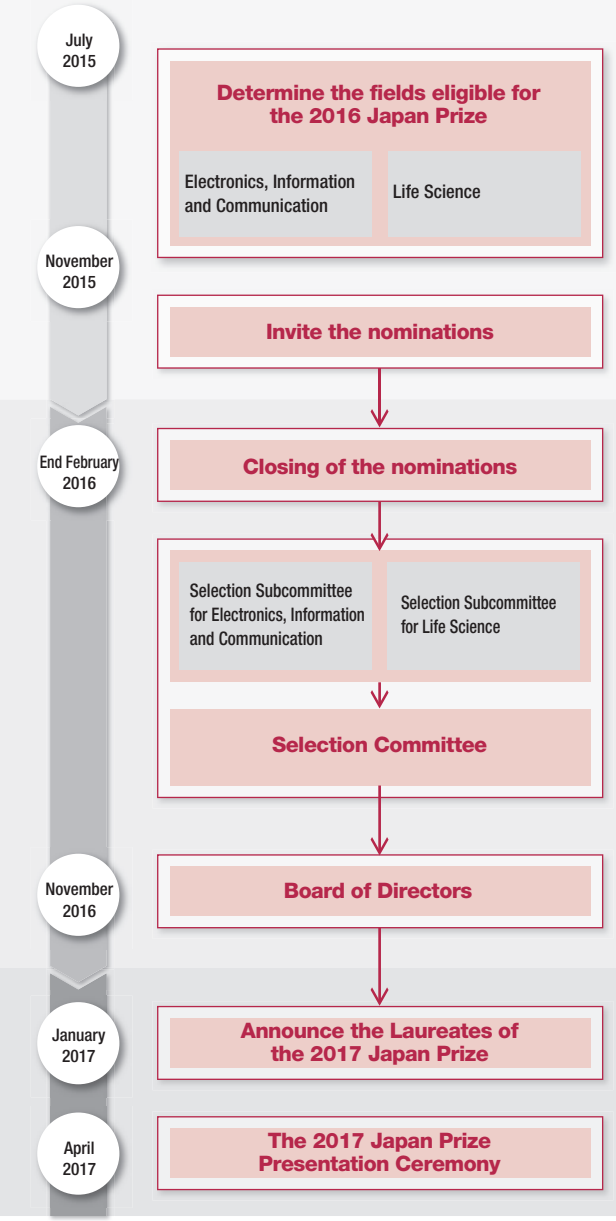


The first President of the Foundation
Konosuke Matsushita

The Japan Prize

Nomination and Selection Process

Nomination and Selection Process



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 13,000 nominators, strictly comprised of prominent scientists and researchers from around the world invited by the Foundation, to nominate the candidates through the web by JPNS (Japan Prize Nomination System). The deadline for nominations is the end of February 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 recipients.

The nomination and selection process takes almost one year from the time that the fields are decided. Every January, the laureates 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 2018 Japan Prize

Chairman
Makoto Asashima
Vice President,
Tokyo University of Science

Vice Chairman
Kazuhito Hashimoto
President,
National Institute
for Materials Science

Vice Chairman
Kohei Miyazono
Professor,
Department of
Molecular Pathology
Graduate School of Medicine
The University of Tokyo

Members

Yozo Fujino
Distinguished Professor, Institute of Advanced Sciences Yokohama National University

Ken Furuya
Professor, Department of Environmental Engineering for Symbiosis, Graduate School of Engineering, Soka University
Specially Appointed Professor, Department of Global Agricultural Sciences, Graduate School of Agricultural and Life Science, The University of Tokyo

Mariko Hasegawa
President,
The Graduate University for Advanced Studies

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

Yuichi Sugiyama
Head, Sugiyama Laboratory,
RIKEN Innovation Center

Mariko Takahashi
Science Coordinator,
The Asahi Shimbun

Masayuki Yamamoto
Director General,
National Institute for Basic Biology

Adviser

Kazuo Kyuma
Executive Member,
Council for Science, Technology and Innovation, Cabinet Office

(alphabetical order, titles as of April, 2017)

Members of the 2017 Japan Prize Selection Committee

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

Vice Chairman
Ryozo Nagai
President,
Jichi Medical University

Members

Yoshinori Fujiyoshi
Guest Professor,
Graduate School of Pharmaceutical Sciences, Nagoya University

Yoshihiro Hayashi
President/Director General,
National Museum of Nature and Science

Yoshio Karita
Director,
The Japan Prize Foundation

Yoichiro Matsumoto
Executive Director,
RIKEN

Masayuki Matsushita
Director,
The Japan Prize Foundation

Yoshinao Mishima
President,
Tokyo Institute of Technology

Shojiro Nishio
President,
Osaka University

Tadatsugu Taniguchi
Project Professor,
Institute of Industrial Science,The University of Tokyo

Selection Subcommittee for the "Electronics, Information and Communication" field

Chairman
Shojiro Nishio
President,
Osaka University

Deputy Chairman
Masaru Kitsuregawa
Director General,
National Institute of Informatics
Professor,
Institute of Industrial Science
The University of Tokyo

Member

Akiko Aizawa
Professor,
National Institute of Informatics

Toru Fujiwara
Professor,
Graduate School of Information Science and Technology, Osaka University

Hiroshi Imai
Professor, Department of Computer Science,
Graduate School of Information Science and Technology, The University of Tokyo

Hironori Kasahara
Professor, Department of Computer Science and Engineering, Waseda University
IEEE Computer Society President 2018

Masanori Koshiba
Professor Emeritus,
Hokkaido University

Hideo Ohno
Director,
Professor, Research Institute of Electrical Communication, Tohoku University

Yuji Oie
President,
Kyushu Institute of Technology

Yasuo Okabe
Professor,
Academic Center for Computing and Media Studies
Kyoto University

Hideyuki Tokuda
Professor,
Faculty of Environment and Information Studies
Keio University

Hiroto Yasuura
Trustee (Vice President),
Kyushu University

Selection Subcommittee for the "Life Science" field

Chairman
Yoshinori Fujiyoshi
Guest Professor,
Graduate School of Pharmaceutical Sciences
Nagoya University

Deputy Chairman
Yoshihiro Yoneda
Director General, National Institutes of Biomedical Innovation, Health and Nutrition

Member

Masatoshi Hagiwara
Professor and Vice Dean,
Graduate School of Medicine, Kyoto University

Yuji Ikegaya
Professor,
Department of Chemical Pharmacology
Graduate School of Pharmaceutical Sciences
The University of Tokyo

Kenji Kadomatsu
Professor,
Department of Biochemistry
Nagoya University Graduate School of Medicine

Mineko Kengaku
Professor,
Institute for Integrated Cell-Material Sciences
Kyoto University

Noboru Mizushima
Professor, Department of Biochemistry and Molecular Biology, Graduate School and Faculty of Medicine, The University of Tokyo

Kiyotaka Okada
Professor,
Department of Agriculture, Ryukoku University

Makoto Sato
Professor, Department of Anatomy and Neuroscience
Graduate School of Medicine, Osaka University

Masato Umeda
Professor, Department of Synthetic Chemistry and Biological Chemistry, Graduate School of Engineering
Kyoto University

(alphabetical order, titles as of April, 2017)

Fields Eligible for the 2018 Japan Prize

Areas of Physics, Chemistry and Engineering

Resources, Energy, Environment and Social Infrastructure

Background and rationale:

A major goal for humankind is the realization of the sustainable development of our society while overcoming various limitations in resources, energy, and the environment, as affirmed by the United Nations' Sustainable Development Goals (SDGs) in 2015. Widening social disparity and the increasing number of communities vulnerable to disasters are of growing concern, as the impact of climate change accumulates and urbanization intensifies.

Thus, we are in serious need of further innovation in the effective development, utilization and recycling of water and resources, various energy-related technologies, and social infrastructure technologies for cities and transportation systems. Another key challenge is to spur innovation in fundamental technologies for the realization of a resilient society capable of predicting and responding to environmental changes, as well as of preventing and mitigating natural and human made disasters.

Achievement eligible:

The 2018 Japan Prize in the field of "Resources, Energy, Environment and Social Infrastructure" is awarded to an individual(s) who has achieved breakthroughs in the creation, innovation, development or dissemination of science and technology, thereby contributing towards the sustainability of human society and the improvement of the global environment.

Areas of Life Science, Agriculture and Medicine

Medical Science and Medicinal Science

Background and rationale:

In recent years, developments in modern science have brought about remarkable advancements in the field of medical science and medicinal science. Revolutionary medical technologies like individually optimized precision medicine driven by personalized diagnosis and genomic medicine, and regenerative medicine have been established one after another, alongside the elucidation of pathological mechanisms for various diseases. While diseases associated with aging and changes in lifestyle are on the rise, emerging infectious diseases and resistant bacteria, fueled by globalization, have also become a worldwide issue.

In such times of change, it is highly anticipated that medical science and medicinal science, integrated with other disciplines like engineering and information science, will make a greater contribution towards healthy living. These include the creation and spread of new medical treatments, the development and production of new drugs as well as the development of drug delivery systems.

Achievement eligible:

The 2018 Japan Prize in the field of "Medical Science and Medicinal Science" is awarded to an individual(s) who has achieved scientific and technological breakthroughs, such as new discoveries or the development of innovative technologies on the "prevention", "diagnosis", "treatment" or "prognosis" of diseases, thereby contributing towards the health and well-being of mankind.

Schedule (2018-2020)

The fields eligible for the Japan Prize (2018 to 2020) 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.

Area of Physics, Chemistry and Engineering

Year	Eligible Fields
2018	Resources, Energy, Environment and Social Infrastructure
2019	Materials, Production
2020	Electronics, Information and Communication

Area of Life Science, Agriculture and Medicine

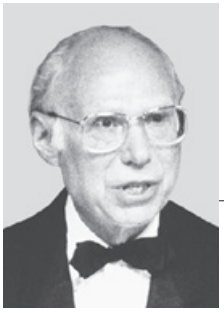
Year	Eligible Fields
2018	Medical Science and Medicinal Science
2019	Biological Production, Biological Environment
2020	Life Science

Profiles of Japan Prize Laureates

(Titles at the time)

1985 (1st)

Field of Information and Communications



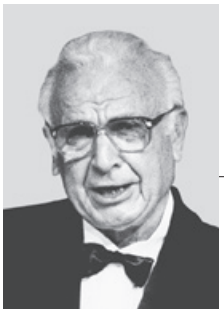
Outstanding achievement in the field of electronics and communications technologies

Dr. John R. Pierce

Professor Emeritus at Stanford University.
USA (1910 - 2002)

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

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

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.

1986 (2nd)

Field of Materials Science and Technology

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

Dr. David Turnbull

Professor at Harvard University.
USA (1915 - 2007)

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

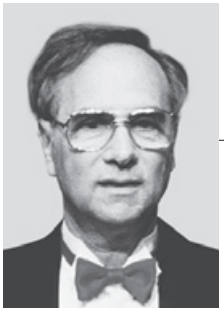
Dr. Willem J. Kolff

Professor at the University of Utah. Head of the Institute for Biomedical Engineering.
USA (1911 - 2009)

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.

1987 (3rd)

Field of Electro-Optics



Realization of the world's first laser

Dr. Theodore H. Maiman

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

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

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

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.

Dr. Gurdev S. Khush

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

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.

1988 (4th)

Field of Energy Technology

Establishment of fast breeder reactor technology

Dr. Georges Vendryes

Scientific advisor to the president of the Commissariat l'Energie Atomique
France (1920 - 2014)

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

The eradication of smallpox (Joint Award)

Dr. Donald A. Henderson

Dean, Johns Hopkins University, School of Hygiene and Public Health
USA Born in 1928

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 success through the worldwide eradication of smallpox.

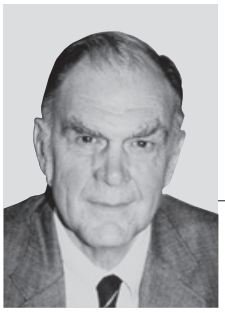
Dr. Isao Arita

Director, Kumamoto National Hospital
Japan Born in 1926

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.

1989 (5th)

Field of Environmental Science and Technology



Studies on the mechanisms of stratospheric ozone depletion by chlorofluorocarbons

Dr. Frank Sherwood Rowland

Profesor at University of California, Irvine
USA (1927 - 2012)

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

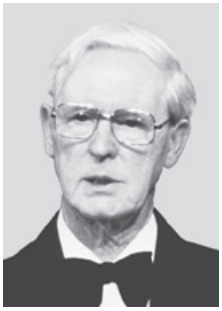
Dr. Elias James Corey

Professor at Harvard University
USA Born in 1928

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.



Dr. Frank Fenner

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

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.

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

Dr. Luc Montagnier

Chief, Department of Virus Tumours, Pasteur Institute
France Born in 1932

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

Chief, Laboratory of Tumour Cell Biology, National Institute of Health
USA Born in 1937

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.

1990 (6th)

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

Professor of Electrical Engineering, MIT
USA (1927 - 2016)

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

Professor at Princeton University
USA Born in 1935

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. Dan Peter McKenzie

Professor at Cambridge University
UK Born in 1942

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. Xavier Le Pichon

Directeur du Département de Géologie,
Ecole Normale Supérieure
France Born in 1937

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.

1991 (7th)

Field of Applied Mathematics

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

Dr. Jacques-Louis Lions

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

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

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

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.

1992 (8th)

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

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

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

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

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.

1993 (9th)

Field of Safety Engineering and Disaster Mitigation

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

Dr. Frank Press

President of U.S. National Academy of Sciences
USA Born in 1924

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

Founder and Vice President Research,
Atomic Tags, Inc.
USA Born in 1944

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.

1994 (10th)

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

Professor Emeritus of the California Institute of Technology
USA (1910 - 2004)

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

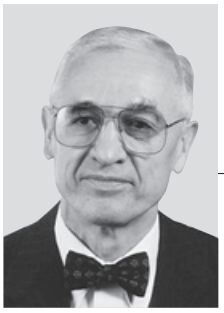
Dr. Arvid Carlsson

Professor Emeritus, Gothenburg University
Sweden Born in 1923

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.

1995 (11th)

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.

Professor, Center for Advanced Study, John Bardeen Chair Professor, University of Illinois
USA Born in 1928

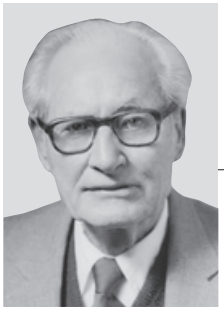
Dr. Holonyak, focused his research on intermetallic compound semiconductors, which led him to the invention of the first practical light emitting diode (LED) by the use of GaAsP crystals. In 1962, he made the first visible light semiconductor laser.

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

Retired Director, Entomology Research Division, Agricultural Research Service
USA (1909 - 2000)

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.

1996 (12th)

Field of Information, Computer and Communication Systems

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

Dr. Charles K. Kao

Vice-Chancellor and President,
The Chinese University of Hong Kong.
USA Born in 1933

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

Director-General, Frontier Research Program, The Institute of Physical and Chemical Research
President, Science Council of Japan
Japan Born in 1928

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.

1997 (13th)

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

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

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. Hiroyuki Yoshikawa

Former President, The University of Tokyo
Japan Born in 1933

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

President Emeritus of National Cancer Center and President of Toho University
Japan Born in 1926

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. Bruce N. Ames

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

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.

1998 (14th)

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

Former President, University of Tsukuba
Japan Born in 1925

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

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

Dr. Marc C.E. Van Montagu

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

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.

1999 (15th)

Field of Information Technologies

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

Dr. W. Wesley Peterson

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

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

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

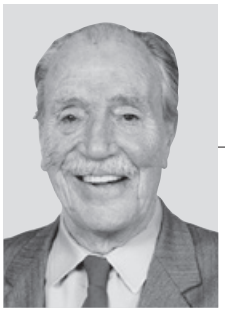
Dr. Don C. Wiley

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

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.

2000 (16th)

Field of City Planning



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

Prof. Ian L. McHarg

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

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

President Emeritus, La Jolla Institute for Allergy and Immunology
Japan Born in 1925

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.

2001 (17th)

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

Professor, University of Texas
USA Born in 1922

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

Professor Emeritus, University of British Columbia
Canada Born in 1932

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.

2002 (18th)

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

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

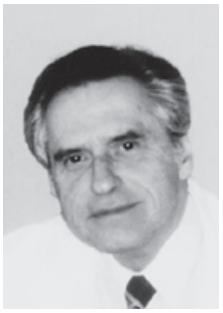
Dr. Berners-Lee is the inventor of the World Wide Web (www). Through his invention people were able to acquire information and work together by combining their knowledge in a web using hypertext documents through the Internet. He implemented the first www using HTML, Hypertext Markup Language developed 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

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



Dr. Andrzej K. Tarkowski

Director of the Institute of Zoology, Warsaw University
Poland Born in 1933

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.

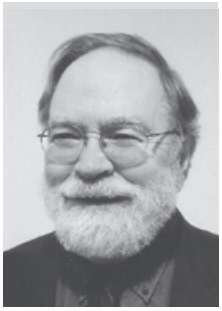
2003 (19th)

Field of Science and Technology of Complexity

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

Dr. Benoit B. Mandelbrot

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



Dr. James A. Yorke

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

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

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

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.

2004 (20th)

Field of Chemical Technology for the Environment

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

Dr. Kenichi Honda

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

Dr. Akira Fujishima

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

Dr. Honda and Dr. Fujishima found that irradiation of solar light onto a single crystal titanium dioxide (T_iO_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 T_iO_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

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

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

Chief Executive, Natural Environment Research Council
UK Born in 1943

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.

2005 (21st)

Field of Information and Media Technology

Pioneering contributions to natural language processing and intelligent image processing

Dr. Makoto Nagao

President, National Institute of Information and Communications Technology
Japan Born in 1936

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

Director of RIKEN Center for Developmental Biology
Japan Born in 1943

Dr. Erkki Ruoslahti

Distinguished Professor, The Burnham Institute
USA Born in 1940

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.

2006 (22nd)

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

Honorary Scientist, Hadley Centre for Climate Prediction and Research and Formerly Chief Executive, Meteorological Office, U.K.
UK Born in 1931

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

Director, Biopharm Research Laboratories, Inc., Tokyo, Japan
Japan Born in 1933

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.

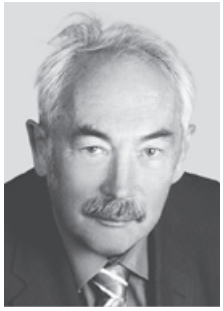
2007 (23rd)

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

University of Paris-South
France Born in 1938



Prof. Dr. Peter Grünberg

The Research Center of Solid State Physics
Germany Born in 1939

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

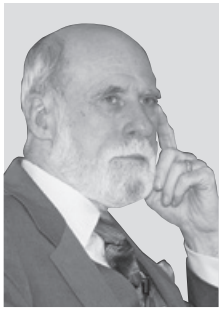
Charles Bullard Professor of Forestry
UK Born in 1934

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.

2008 (24th)

Field of Information Communication Theory and Technology

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



Dr. Vinton G.Cerf

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

Dr. Robert E.Kahn

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

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

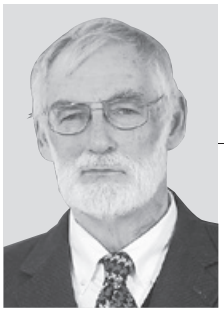
Dr. Victor A. McKusick

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

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.

2009 (25th)

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

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

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

Professor, Radiology,
University of Michigan Medical School
USA Born in 1929

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.

2010 (26th)

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

Director, Tohoku Institute of Technology
Professor Emeritus, Tohoku University
Japan Born in 1926

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

Professor of Biology, Stanford University
USA Born in 1949

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.

2011 (27th)

Field of Information and Communications

Development of the operating system, UNIX (Joint Award)

Dr. Dennis M. Ritchie

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

Dr. Ken L. Thompson

Distinguished Engineer, Google Inc.
USA Born in 1943

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

Emeritus Professor, Osaka University
Japan Born in 1939

Dr. Toshio Hirano

Professor, Osaka University
Japan Born in 1947

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.

2012 (28th)

Field of Healthcare and Medical Technology

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

Dr. Janet D. Rowley

Blum-Riese Distinguished Service Professor of Medicine, Molecular Genetics & Cell Biology and Human Genetics, The University of Chicago
USA (1925 - 2013)

Dr. Brian J. Druker

Professor and Director of OHSU Knight Cancer Institute, Oregon Health & Science University
USA Born in 1955

Dr. Nicholas B. Lydon

Founder and Director, Blueprint Medicines
USA Born in 1957

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.

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

President, Intermetallics Co., Ltd.
Japan Born in 1943

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.

2013 (29th)

Field of Materials and Production

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

Prof. C. Grant Willson

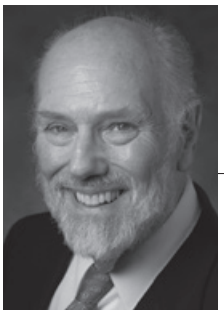
Professor of Chemistry
and Chemical Engineering
The University of Texas at Austin
USA Born in 1939

Prof. Jean M. J. Fréchet

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

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

Professor Emeritus,
Rutgers, The State University of New Jersey
USA Born in 1939

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.

2014 (30th)

Field of Electronics, Information and Communication

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

Dr. Yasuharu Suematsu

Honorary Professor,
Tokyo Institute of Technology
Japan　Born in 1932

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

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

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.

2015 (31st)

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

Professor Emeritus, University of Tokyo
Japan Born in 1927

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

Professor of Pediatrics, University of California San Diego,
School of Medicine
USA Born in 1935

Prof. Alain Fischer

Professor at Collège de France,
Director of Institute Imagine, Hôpital Necker-Enfants malades
France Born in 1949

"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.

2016 (32nd)

Field of Materials and Production

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

Dr. Hideo Hosono

Laboratory for Materials and Structures, Institute of Innovative Research, Tokyo Institute of Technology
Director, Materials Research Center of Element Strategy
Japan Born in 1953

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

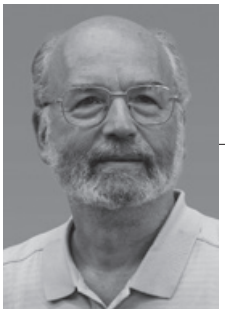
Professor Emeritus,
Cornell University
USA Born in 1954

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.

2017 (33rd)

Field of Electronics, Information and Communication



Contribution to information security through pioneering research on cryptography

Dr. Adi Shamir

Professor,
Weizmann Institute of Science
Israel Born in 1952

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

Director,
Max Planck Institute
for Infection Biology (Berlin)
France Born in 1968

Dr. Jennifer A. Doudna

Professor,
University of California, Berkeley
USA Born in 1964

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.

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