

## The 2022 Kyoto Prize Laureates Announced

The Inamori Foundation (President: Shinobu Inamori-Kanazawa) is pleased to announce the laureates of the 2022 Kyoto Prize, an international award presented to individuals who have contributed significantly to the scientific, cultural, and spiritual betterment of humankind. Each laureate will receive a diploma, the Kyoto Prize medal (20K gold), and prize money of 100 million yen. This year's Prize goes to the following three individuals.

### Advanced Technology Prize Field: Electronics



#### Carver Mead

Electronics Engineer and Applied Physicist  
b. May 1, 1934 / Age 88

Gordon and Betty Moore Professor of Engineering and Applied Science,  
Emeritus, California Institute of Technology

#### Leading Contributions to the Establishment of the Guiding Principles for VLSI Systems Design

Carver Mead proposed and promoted a new methodology to divide the increasingly complicated design process of very large-scale integration (VLSI) systems into logic, circuit, and layout designs, and to separate them from the manufacturing process. He also contributed greatly to the advancement of computer-aided design technology and paved the way to the electronic design automation of VLSIs that led to the immense development of VLSI-based electronics and industry.

### Basic Sciences Prize Field: Biological Sciences (Evolution, Behavior, Ecology, Environment)



#### Bryan T. Grenfell

Population Biologist  
b. December 7, 1954 / Age 67

Kathryn Briger and Sarah Fenton Professor of Ecology and Evolutionary Biology  
and Public Affairs, Princeton University

#### Development of an Innovative Methodology for Integrative Analysis of Pathogen Evolution and Epidemics

Bryan T. Grenfell proposed “phylodynamics,” a methodology that predicts infectious disease dynamics of RNA viruses by considering viral evolution, and thus contributed to the development of the research field that integrates immune dynamics, epidemiology, and evolutionary biology. By virtue of these achievements, he has been instrumental in understanding infection mechanisms and proposing effective infectious disease control policies.

### Arts and Philosophy Prize Field: Music



#### Zakir Hussain

Tabla Player  
b. March 9, 1951 / Age 71

#### A Highly Innovative and Creative Artist who Opened up the New Musical Possibilities of the Tabla, a Traditional Indian Percussion Instrument

A leading tabla player of Hindustani music, Zakir Hussain transcended the framework of traditional Indian music and opened up a new world of music by collaborating with musicians of various genres from around the world. With his superb technique, engaging performances, and rich creativity, he made a tremendous impact on musicians worldwide.

# BIOGRAPHY OF THE 2022 KYOTO PRIZE LAUREATE IN ADVANCED TECHNOLOGY

Prize Field: Electronics

## Carver Mead

Electronics Engineer and Applied Physicist

**Affiliation and Title/Position**      Gordon and Betty Moore Professor of Engineering and Applied Science, Emeritus, California Institute of Technology

### Brief Biography

1934              Born in Bakersfield, California, U.S.A.  
1959–1962        Assistant Professor, California Institute of Technology (Caltech)  
1960              Ph.D. in Electrical Engineering, Caltech  
1962–1967        Associate Professor, Caltech  
1967–1977        Professor, Caltech  
1977–1980        Professor of Computer Science and Electrical Engineering, Caltech  
1980–1992        Gordon and Betty Moore Professor of Computer Science, Caltech  
1992–1999        Gordon and Betty Moore Professor of Engineering and Applied Science, Caltech  
1999–             Gordon and Betty Moore Professor of Engineering and Applied Science, Emeritus, Caltech

### Selected Awards and Honors

1971              Thomas D. Callinan Award, Electrochemical Society  
1981              Achievement Award (with Lynn Conway), Electronics Magazine  
1984              IEEE Centennial Medal  
1984              Harold Pender Award (with Lynn Conway), University of Pennsylvania  
1985              AFIPS Harry H. Goode Memorial Award  
1985              John Price Wetherill Medal (with Lynn Conway), Franklin Institute  
1987              Honorary Doctorate, Lund University  
1987              Walter B. Wriston Public Policy Award, Hudson Institute  
1991              Honorary Degree, Doctor of Science, University of Southern California  
1996              IEEE John Von Neumann Medal  
1997              ACM-AAAI Allen Newell Award  
1999              Lemelson-MIT Prize  
2001              Dickson Prize in Science, Carnegie Mellon University  
2002              National Medal of Technology and Innovation  
2003              Simon Ramo Founders Award, National Academy of Engineering  
2009              National Inventors Hall of Fame Inductee  
2011              BBVA Foundation Frontiers of Knowledge Award in Information and Communication Technologies

Memberships:    American Academy of Arts and Sciences, American Physical Society, Franklin Institute, IEEE, National Academy of Engineering, National Academy of Inventors, National Academy of Sciences, Royal Swedish Academy of Engineering Sciences

# ACHIEVEMENTS OF THE 2022 KYOTO PRIZE LAUREATE IN ADVANCED TECHNOLOGY

Prize Field: Electronics

## Carver Mead

### Leading Contributions to the Establishment of the Guiding Principles for VLSI Systems Design

In the early stages of VLSI (very large-scale integration) development, Carver Mead paid attention to the increasing complexity of its design and manufacturing processes. He proposed a new methodology to divide the design process into three stages, namely, logic, circuit, and layout designs, and to separate them from the manufacturing process. By employing computer-aided design (CAD) technology in each stage of the design process, he helped establish the basic framework for VLSI design, facilitated the separation of system design from device fabrication, and thus enabled efficient synergies between the two. Consequently, he laid the foundation for intercorporate/international division of roles in VLSI design and fabrication, and contributed greatly to the development of VLSI-based electronics technology and industry.

In the late 1970s, it was predicted that advances in miniaturization of devices in integrated circuits (ICs) would enable the realization of VLSI systems comprising billions of transistors (1). Mead revised radically the design process for increasingly complex VLSI systems, and proposed a method to simplify and standardize the process of layout design which had previously varied among manufacturers. He also developed CAD technology for VLSI systems, and enabled the separation of the design process, including the logic and circuit design stages, from the manufacturing process (2). This achievement paved the way for electronic design automation that covered a text-based description of the system operation and the automatic generation of the layout required for chip manufacturing. Thus, he established the guiding principles for VLSI system design involving billions of transistors on a single chip.

The book entitled *Introduction to VLSI Systems* (3), co-authored with Lynn Conway, provided a clear methodology (4) for system designers to perform VLSI design without knowledge of complicated manufacturing processes. It allowed many engineers and students to participate in VLSI design, prototype fabrication, and testing, and thus contributed considerably to the subsequent progress of VLSI. In particular, this book proposed and disseminated the multi-project chip concept that enabled the prototyping of chips at a reasonable cost by fabricating multiple, individually designed IC systems on a single wafer. All these accomplishments contributed enormously to the acceleration of education, research, and development which involved ICs, LSIs and VLSIs.

Mead also predicted that the large part of the VLSI industry would be divided into many design companies (fabless) and a far-smaller number of specialized manufacturers (fabs). This prediction laid the foundation for the complementary division of tasks and roles among various corporates (5). It is safe to say that the semiconductor industry centered on VLSI would not

have existed without these contributions. VLSI has been incorporated into a variety of industrial products, including home appliances, vehicles, mobile phones, and computers. It is no exaggeration to state that these contributions have ushered in our current information-based society.

### References

- (1) Sutherland IE & Mead CA (1977) Microelectronics and Computer Science. *Scientific American* **237**: 210–229.
- (2) Mead CA (1979) VLSI and Technological Innovation. In *Proceedings of the Caltech Conference on Very Large Scale Integration*, California Institute of Technology: 15–27.
- (3) Mead C & Conway L (1980) *Introduction to VLSI Systems*. Addison-Wesley.
- (4) Mead CA & Lewicki G (1982) Silicon compilers and foundries will usher in user designed VLSI. *Electronics* **55**: 107–111.
- (5) Casale-Rossi M *et al.* (2013) Panel: The heritage of Mead & Conway What has remained the same, what was missed, what has changed, what lies ahead. In *Design, Automation & Test in Europe Conference & Exhibition (DATE)*, IEEE: 171–175.

# BIOGRAPHY OF THE 2022 KYOTO PRIZE LAUREATE IN BASIC SCIENCES

Prize Field: Biological Sciences (Evolution, Behavior, Ecology, Environment)

## **Bryan T. Grenfell**

Population Biologist

**Affiliation and Title/Position** Kathryn Briger and Sarah Fenton Professor of Ecology and Evolutionary Biology and Public Affairs, Princeton University

### **Brief Biography**

1954 Born in Swansea, U.K.  
1981 D.Phil., University of York  
1981–1986 Research Fellow, Department of Pure and Applied Biology, Imperial College London  
1986–1990 Lecturer, Department of Animal and Plant Sciences, University of Sheffield  
1990–1998 Lecturer, Department of Zoology, University of Cambridge  
1998–2002 Reader, Department of Zoology, University of Cambridge  
2002–2004 Professor of Population Biology, Department of Zoology, University of Cambridge  
2004–2009 Alumni Professor of Biology, Pennsylvania State University  
2009– Kathryn Briger and Sarah Fenton Professor of Ecology and Evolutionary Biology and Public Affairs, Department of Ecology and Evolutionary Biology and Princeton School of Public and International Affairs, Princeton University  
2014–2021 Member of Governing Board, Wellcome Trust

### **Selected Awards and Honors**

1991 T.H. Huxley Medal of Imperial College, London  
1994 Scientific Medal of the Zoological Society of London  
Memberships: American Academy of Arts and Sciences, American Association for the Advancement of Science, Royal Society

# ACHIEVEMENTS OF THE 2022 KYOTO PRIZE LAUREATE IN BASIC SCIENCES

Prize Field: Biological Sciences (Evolution, Behavior, Ecology, Environment)

**Bryan T. Grenfell**

## **Development of an Innovative Methodology for Integrative Analysis of Pathogen Evolution and Epidemics**

Pathogens threaten the lives of many organisms, including human beings. Vertebrates have developed adaptive immunity that prevents reinfection with the same pathogen. However, evolution by mutation enables pathogens to evade host immune responses. In 2004, Bryan T. Grenfell proposed “phylodynamics,” a new methodology that predicts the epidemic dynamics of RNA viruses by considering viral evolution and contributed to the development of the research field that integrates immune dynamics, epidemiology, and evolutionary biology.

In the phylodynamics framework, pandemic frequency and periodicity are analyzed by traditional epidemic models incorporating both dynamics of hosts’ immunity acquisition and pathogens’ immune evasion. Phylodynamics explains the major differences in the epidemic dynamics and evolutionary patterns of RNA viruses by the differences in the viral evolutionary potential to evade the host’s immunity by mutation (antigenic drift).

Grenfell began his research on wildlife population dynamics and later moved on to study zoonotic diseases. He successfully constructed a comprehensive framework that analyzes and predicts various infectious disease dynamics. He first developed a method for estimating parameters related to infectious processes in non-linear dynamical models that may exhibit chaotic behavior using long-term spatiotemporal data including uncertainty, which allows reliable predictions. Subsequently, he invented a method to detect spatial spread of infection in traveling waves. He also analyzed the spatiotemporal dynamics of measles using 50-year long-term statistics of the number of patients with measles. By applying these methodologies to various infectious disease data, such as those of influenza, foot-and-mouth disease, and dengue, Grenfell promoted the understanding of infection mechanisms and proposed effective control policies for various infectious diseases.

After the emergence of COVID-19, Grenfell investigated the evolutionary and epidemiological dynamics of the virus by considering the effectiveness of vaccination and the decline in its effects and discussed the vaccination policy to reduce the evolution of novel mutants. A series of these works are products of his research on wildlife population dynamics, and they are important for overcoming the COVID-19 pandemic, which is a major humanitarian crisis. This demonstrates the importance of basic research in ecology and evolutionary biology. For these reasons, Bryan T. Grenfell deserves the Kyoto Prize in Biological Sciences field in Basic Sciences category.

# BIOGRAPHY OF THE 2022 KYOTO PRIZE LAUREATE IN ARTS AND PHILOSOPHY

Prize Field: Music

## Zakir Hussain

Tabla Player

### Brief Biography

1951	Born in Mumbai, India
1970	Performed his first U.S. concert at the Fillmore East in New York City with Ravi Shankar
1974	Formed Shakti, the landmark collaboration with John McLaughlin
1987	Released his first solo album, <i>Making Music</i>
1991	Joined the creation of <i>Planet Drum</i> , the first recording to win a Grammy Award for the Best World Music Album
1999	Formed Tabla Beat Science with Bill Laswell
2007	Chosen to compose an anthem to celebrate India's 60th year of independence by the government of India
2008–2009	Chosen to present his work at Carnegie Hall's Perspectives Series
2011	<i>Concerto for Four Soloists</i> commissioned by National Symphony Orchestra
2014	Commissioned to compose first-ever tabla concerto by Symphony Orchestra of India (premiered in 2015)

### Selected Awards and Honors

1988	Padma Shri
1991	Sangeet Natak Akademi Award
1999	NEA National Heritage Fellow
2002	Padma Bhushan
2009	Best Contemporary World Music Album, the 51st Annual Grammy Awards
2017	SFJAZZ Lifetime Achievement Award
2019	Fellowship of Sangeet Natak Akademi

### Selected Discography

1976	<i>Shakti with John McLaughlin</i> (Shakti), Columbia
1987	<i>Making Music</i> , ECM Records
1991	<i>Planet Drum</i> (Mickey Hart), Rykodisc
1999	<i>Remember Shakti</i> (Remember Shakti), Verve Records
2006	<i>Sangam</i> (Charles Lloyd), ECM Records
2007	<i>Global Drum Project</i> (Mickey Hart, Zakir Hussain, Sikiru Adepoju, and Giovanni Hidalgo), Shout! Factory
2009	<i>The Melody of Rhythm</i> (Béla Fleck, Zakir Hussain, and Edgar Meyer), E1 Entertainment
2019	<i>Good Hope</i> (Dave Holland, Zakir Hussain, Chris Potter), Edition Records

# ACHIEVEMENTS OF THE 2022 KYOTO PRIZE LAUREATE IN ARTS AND PHILOSOPHY

Prize Field: Music

## Zakir Hussain

### **A Highly Innovative and Creative Artist who Opened up the New Musical Possibilities of the Tabla, a Traditional Indian Percussion Instrument**

Zakir Hussain, a leading tabla player of Hindustani (North Indian classical) music since the late 20th century, opened up a new musical world beyond the framework of traditional Indian music by collaborating with musicians of various genres worldwide. His innovative creativity, such as devising a method of playing a melody on the tabla—traditionally a rhythmic instrument of accompaniment—significantly expanded the musical possibilities of the instrument and established the tabla as one of the most popular Asian instruments in the world.

Born in India in 1951, the son of Alla Rakha—who was known for his tabla accompaniment to the renowned sitar player Ravi Shankar, he made his debut in his childhood and received acclaim as a prodigy. He accompanied Shankar on his US tour in 1970 and has since accompanied a succession of prominent Hindustani musicians. He has established himself as one of India's leading tabla players, bringing out the best in this instrument through his superb technique based on his rich creativity.

Zakir Hussain played a leading role in collaborations with several musicians across genres. His work with guitarist John McLaughlin and the fusion group Shakti, which they formed with Karnatak (South Indian classical) musicians, opened up new dimensions of Indian music and inspired new tabla players around the world. He also participated in percussionist Mickey Hart's global percussion music creation project, which resulted in the albums *Planet Drum* (1991) and *Global Drum Project* (2007), both of which won Grammy Awards. Zakir Hussain has also enjoyed great success in collaborations with Western music, including the world tour of Tabla Beat Science, a musical project involving several tabla players, and a performance with the BBC Symphony Orchestra.

Zakir Hussain has tremendously influenced genre-bending musicians in India and around the world with his superb skill on the tabla, captivating performances, and the rich creativity that backs them. The impact of his activities over the past half a century is immeasurable.