THE FRANKLIN INSTITUTE *Awards* & CONVOCATION

APRIL 27–MAY 1, 2026

The 2026 Franklin Institute

AWARDS CONVOCATION

APRIL 27–MAY 1, 2026

Welcome to The Franklin Institute Awards, the oldest comprehensive science and technology awards program in the United States. As the nation marks its semiquincentennial, we reflect with pride on The Franklin Institute's role in advancing America's early leadership in industry, innovation, and education. When the Institute was founded in 1824, Philadelphia stood at the center of the young nation's industrial growth. From crucial advances supporting the Industrial Revolution to creating dynamic science experiences for families, students, and lifelong learners, we continue to build on our enduring legacy of connecting our community to the power and promise of science and engineering.

Through The Franklin Institute Awards, we celebrate the transformative power of discovery and the extraordinary individuals whose brilliance, vision, and perseverance have shaped science, engineering, and industry on a global scale. During the past two centuries, we have recognized more than 2,000 of these incredible innovators. This year, we are honored to welcome eight new laureates to this distinguished community, each of whom embodies the curiosity, ingenuity, and bold spirit of Benjamin Franklin.

The achievements of the Class of 2026 span a broad spectrum of scientific discovery, from the smallest units of life to the vast expanse of the universe—from exploring human thought to understanding how we use and shape our environment, from advancing sustainable solutions through innovative plastics to developing tools for pollution remediation, and from revolutionizing the treatment of disease to designing algorithms that drive progress across science and engineering. Our laureates have pioneered new fields of inquiry and transformed entire disciplines, preserving vital pieces of our past and charting bold paths to the future. To honor them, we are pleased to present a series of events showcasing their stories and groundbreaking work. These programs offer the public meaningful opportunities to engage with these remarkable individuals and to explore a wide range of scientific and engineering disciplines.

In this convocation book, you will find a schedule of events and biographies of this year's laureates. We invite you to read about them and join us in celebrating their impact. We believe the members of our Class of 2026 will spark your curiosity as deeply as they have ours.

Thomas J. Lynch
CHAIR, BOARD OF TRUSTEES
THE FRANKLIN INSTITUTE

Larry Dubinski
PRESIDENT AND CEO
THE FRANKLIN INSTITUTE

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THE FRANKLIN INSTITUTE AWARDS

The Franklin Institute Awards date back more than two centuries, to the first days of the Institute itself. When The Franklin Institute was founded in 1824 by a group of leading Philadelphians to train artisans and mechanics, Philadelphia was the largest city in the United States and the nation's innovation and manufacturing center. The same year, the Institute arranged the first of what became a series of regular exhibitions of manufactured goods. With the exhibitions came the presentation of awards—first certificates and later endowed medals—for technical achievement.

Since 1875, recipients have been selected by the Institute's Committee on Science and the Arts (CS&A), formerly known as the Committee on Inventions. This all-volunteer committee of distinguished scientists and engineers from academia and industry still selects recipients of the Benjamin Franklin Medals and NextGen Award, dedicated to their charge to recognize the world's most impactful advances in science and engineering.

Celebrating outstanding achievements in science and technology from around the world is an important way The Franklin Institute preserves Benjamin Franklin's legacy.

In 1998, the Institute's long-standing endowed Awards Program was reorganized under the umbrella of the Benjamin Franklin Medals, presented in seven fields of science and engineering. The Bower Award for Business Leadership and the Bower Award and Prize for Achievement in Science were made possible by a bequest in 1988 from Philadelphia chemical manufacturer and philanthropist Henry Bower, who was a member of the Committee on Science and the Arts and the grandson of a 19th century Franklin Institute laureate. 2021 marked the launch of the Benjamin Franklin NextGen Award, the first new award to be established in more than two decades, and the only award to specifically recognize young researchers whose work is proving transformational in their fields.

Through its Awards Program, The Franklin Institute seeks to provide public recognition and encouragement of excellence in science and technology. The list of Franklin Institute laureates virtually charts their advancement through the past two centuries—from the development of the typewriter to the dawn of quantum computing. The honor roll of more than 2,000 Franklin Institute Awards laureates includes Nikola Tesla, Marie and Pierre Curie, Orville Wright, Thomas Edison, Max Planck, Orville Wright, Albert Einstein, Edwin Hubble, Frank Lloyd Wright, Gordon Moore, Jane Goodall, Elizabeth Blackburn, Steven Squyres, Subra Suresh, Cornelia Bargmann, Jim Allison, Frances Arnold, Kizzmekia Corbett, Katalin Karikó, Drew Weissman, Paula Hammond, and Lisa Su—to name but a few.

The Franklin Institute

In the spirit of inquiry and discovery embodied by Benjamin Franklin, the mission of The Franklin Institute is to inspire a passion for learning about science and technology.

Located in the heart of Philadelphia, The Franklin Institute is a leading science museum dedicated to inspiring a passion for science and technology learning through interactive exhibits and impactful nationwide educational programs. As Pennsylvania's most visited museum, TFI has established itself as a premier North American venue for hosting world-renowned traveling exhibitions. Home to the historic Fels Planetarium, the second oldest in the Western Hemisphere, and the Benjamin Franklin National Memorial, the museum also houses nationally significant curatorial collections, particularly those related to Benjamin Franklin and the Wright Brothers. Now in its 202nd year, The Franklin Institute continues to lead with innovation as a dynamic center of exploration and a top destination for curious minds seeking to explore the wonders of science and technology. For more information, visit www.fi.edu.

THE FRANKLIN INSTITUTE LAUREATES

The Franklin Institute congratulates the 2026 Franklin Institute laureates, trailblazers in their fields who have benefitted humanity and deepened our understanding of the universe and its inhabitants.

David R. Liu, Ph.D.
Bower Award and Prize for Achievement in Science

Pedro J.J. Alvarez, Ph.D.
Benjamin Franklin Medal in Civil Engineering

David M. Rubenstein
Bower Award for Business Leadership

Dedre Gentner, Ph.D.
Benjamin Franklin Medal in Computer and Cognitive Science

Josh Alman, Ph.D.
Benjamin Franklin NextGen Award

Karen C. Seto, Ph.D.
Benjamin Franklin Medal in Earth and Environmental Science

Geoffrey W. Coates, Ph.D.
Benjamin Franklin Medal in Chemistry

Wendy Laurel Freedman, FRS
Benjamin Franklin Medal in Physics

Awards Event Schedule

This year's slate of laureate programs includes in-person and hybrid events. All times listed are Eastern Time (ET) and are speaking program start times. Many in-person events offer refreshments and a registration period prior to the listed time. Please refer to www.fi.edu/awards-week for more details, including featured speakers, location details, and participation instructions.

TUESDAY, APRIL 28, 2026

7:00–8:30 PM

Engineering Hope: How Gene Therapies are Rewriting Medicine

Honoring the innovations of 2026 Bower Award and Prize for Achievement in Science Laureate David Liu, this interactive event will explore how gene therapies are transforming biomedical research and changing people's lives.

Hosted by The Franklin Institute in partnership with the Penn Memory Center, Gemma Biotherapeutics, and the National Organization for Rare Disorders

WEDNESDAY, APRIL 29, 2026

8:45 AM–12:30 PM

Environmental Nanotechnology

Laureate Symposium honoring Pedro Alvarez, 2026 Benjamin Franklin Medal in Civil Engineering

Hosted by Villanova College of Engineering in partnership with the Villanova Center for Human-Environmental Systems and the Villanova Center for Resilient Water Systems

9:00 AM–1:30 PM

Base Editing and Prime Editing: Precision Therapeutic Genome Editing in Cells, Animals, and Patients

Laureate Symposium honoring David Liu, 2026 Bower Award and Prize for Achievement in Science

Hosted by the University of Pennsylvania Perelman School of Medicine and the Children's Hospital of Philadelphia

9:00 AM–3:30 PM

Charting the Cosmos: From Distance Ladders to Precision Cosmology

Laureate Symposium honoring Wendy Freedman, 2026 Benjamin Franklin Medal in Physics

Hosted by the University of Pennsylvania Department of Physics and Astronomy and Center for Particle Cosmology

9:30–10:30 AM

Algorithms and Barriers for Fast Matrix Multiplication

Laureate Address by Josh Alman, 2026 Benjamin Franklin NextGen Award

Hosted by Drexel University

10:00 AM–12:00 PM

Cooling Hot Cities

Laureate Symposium honoring Karen Seto, 2026 Benjamin Franklin Medal in Earth and Environmental Science

Hosted by Temple University

THURSDAY, APRIL 30, 2026

9:00 AM–12:00 PM

Sustainable Plastics

Symposium honoring Geoffrey Coates, 2026 Benjamin Franklin Medal in Chemistry

Hosted by the University of Delaware

11:00 AM–12:30 PM

Why We're So Smart: Analogy and Abstraction Drive Human Learning

Laureate Address by Dedre Gentner, 2026 Benjamin Franklin Medal in Computer and Cognitive Science

Hosted by Temple University

Awards Week Sponsors

KPMG

Marsha and Jeffrey Perelman

THE FRANKLIN INSTITUTE *Awards*
CEREMONY & DINNER

THURSDAY, APRIL 30, 2026 | 5:30 PM

Presented by BANK OF AMERICA

For event information, visit www.fi.edu/awards/ceremony-and-dinner

David Greed
2026 Awards Corporate Committee Chair

Stephen and Michelle Kelly
2026 Host Committee Co-Chairs

Mimi Drake
2026 Awards Corporate Committee Vice Chair

BOWER AWARD AND PRIZE FOR ACHIEVEMENT IN SCIENCE THEME - HUMAN GENE THERAPY

David R. Liu, Ph.D.

Richard Merkin Professor, Director of the Merkin Institute, and Core Institute Member, Broad Institute
Investigator, Howard Hughes Medical Institute
Thomas Dudley Cabot Professor of the Natural Sciences and Professor of Chemistry & Chemical Biology, Harvard University
Cambridge, Massachusetts

CITATION: For pioneering an exciting new class of precise and effective gene-editing technologies that enable a broad range of applications in science, industry, and medicine, including the direct correction of many disease-causing mutations.

Inside every living cell, life runs on instructions. And some of the most devastating genetic diseases begin the same way: not with a missing chapter, but with a single misprinted word in that instruction manual. For a long time, medicine could read those errors but not fix them. We could diagnose, predict, and counsel, yet correcting the underlying mistake remained out of reach. Over the past decade, David Liu and his laboratory changed that reality by creating the first ways to rewrite DNA in living systems, including human patients, with a precision that once sounded like science fiction.

To appreciate what Liu and colleagues contributed, it helps to understand the challenges of early gene editing approaches. The CRISPR revolution gave scientists a way to target a specific DNA location and make a cut. But cuts are blunt instruments, and cutting DNA in most cells, including those in patients, disrupts genes, rather than correcting the genetic misspellings that cause diseases. For researchers and clinicians aiming to correct the smallest mistakes, the dream became clear: editing that fixes the right word in the right chapter, and nowhere else.

Liu's answer was base editing. Rather than cutting both strands of DNA and hoping the cell repairs them in just the right way, base editors use chemistry to convert one DNA letter, or base, into another at a targeted location. The first widely cited demonstration fused a programmable DNA-targeting system to laboratory-engineered enzymes that chemically change a specific base, enabling direct single-letter conversions without double-strand cuts.

The practical significance is easy to state even if the molecular details are complex: a large fraction of known disease-causing mutations are single-letter changes, and base editing was built to address that problem at its source. As base editing matured, the concept broadened. Different base editors were engineered to make different kinds of letter swaps, extending the range of correctable "typos." The field also learned, in real time, that precision is not a single number. It is a design problem. Where exactly does the conversion happen? How often does it occur at the intended site? How often elsewhere? Which cell types will tolerate the process? Liu's group became known for pushing on all of those questions at once, improving performance to levels that offered patients suffering from grievous genetic diseases very favorable potential benefits with minimized risks.

In 2019, Liu and his laboratory developed a second leap: prime editing. Base editing corrects single-letter spelling errors, while prime editing performs "search-and-replace" on the genome of living cells. Prime editing directly writes new genetic information into a specified DNA site, expanding beyond certain single-letter swaps to a broader range of insertions, deletions, and all 12 possible substitutions. Prime editing enables the genome to be treated as something that can be precisely revised, empowering clinicians to tailor treatment to a patient's exact mutation.

What makes these advances especially exciting is that they are not isolated tricks. They come from Liu's broader philosophy about how biology is best engineered with the goal of tangible results in the real world. Liu and his lab didn't just create the first precise gene editors to prove a concept, they built what amounts to open-source gene-editor creation kits that doctors and scientists can use to reliably build patient-specific prime and base editors, along with delivery methods that could make such systems usable in living organisms. That emphasis on delivery is crucial. Editing that works beautifully in a dish is not the same as editing that can safely reach the right cells in a body. The distance between the two is where many medical revolutions stall. Liu's work is often framed not just as discovery, but as translation: building tools that can leave the lab.

And they have. During the last half decade, the Liu lab's base editors and prime editors have been applied in real patients in at least 23 clinical trials, treating a wide range of genetic diseases including cancers, liver diseases, blood diseases, neurodegenerative diseases, muscular dystrophy, heart disease, immunodeficiencies, and other serious conditions. In all eight clinical trials with results reported thus far, the treatments have led to dramatic benefits to patients. In the case of teenager Alyssa Tapley, Liu's technique was used to engineer healthy immune cells to attack her otherwise untreatable T-cell leukemia, saving her life. Branden Baptiste's sickle-cell disease appears to be cured by base editing. Tracy Attebury's broken immune system is now functional for the first time thanks to prime editing. And baby K.J. Muldoon, born with an often-fatal liver disease, was treated less than 7 months after birth by a base editor customized to correct his specific single-letter misspelling—and is now thriving.

David Liu's career is a reminder that the most consequential engineering can be almost invisibly small. A single letter in DNA can separate health from death. By giving science ways to revise those letters with increasing precision, Liu has helped turn genetics from a language we read into a language we can, in many cases, precisely edit. And at a time when more diseases are understood as molecular instructions gone wrong, that shift is not just a technical milestone. It is a new kind of hope, grounded in the craft of rewriting life's most fundamental text.

David Liu was born and raised in Riverside, California. He earned an A.B. from Harvard University in 1994 and a Ph.D. in organic chemistry from the University of California, Berkeley in 1999. He joined Harvard's faculty in chemistry and chemical biology in 1999, became an investigator of the Howard Hughes Medical Institute in 2005, and directs the Merkin Institute at the Broad Institute focused on transformative technologies in healthcare.

Previous Recipients of the Bower Award and Prize for Achievement in Science

1990/91	PAUL C. LAUTERBUR
1991/92	SOLOMON H. SNYDER
1992/93	DENIS PARSONS BURKITT
1993/94	ISABELLA L. KARLE
1994/95	CHEN NING YANG
1995/96	FREDERICK P. BROOKS
1997	RALPH L. BRINSTER
1998	SIR MARTIN REES
1999	RALPH J. CICERONE
2000	ALEXANDER RICH
2001	PAUL BARAN
2002	JOHN W. CAHN
2003	PAUL B. MACCREADY
2004	SEYMOUR BENZER
2005	HENRI B. KAGAN
2006	NARAIN G. HINGORANI
2007	STUART K. CARD
2008	TAKEO KANADE
2009	SANDRA M. FABER
2010	W. RICHARD PELTIER
2011	GEORGE M. CHURCH
2012	LOUIS E. BRUS
2013	KENICHI IGA
2014	EDMUND M. CLARKE
2015	JEAN-PIERRE KRUTH
2016	WILLIAM J. BORUCKI
2017	CLAUDE LORIUS
2018	PHILIPPE HORVATH
2019	FRANCES H. ARNOLD
2021	KUNIHIKO FUKUSHIMA
2022	PAUL SLOVIC
2023	DEB NIEMEIER
2024	DAVID A. WEITZ
2025	KATHARINE SUDING

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Learn more about Dr. Liu and his work at "Engineering Hope: How Gene Therapies are Rewriting Medicine" on April 28 and "Base Editing and Prime Editing: Precision Therapeutic Genome Editing in Cells, Animals, and Patients" on April 29.

— See page 4 for details.

LAUREATE SPONSOR:

Bradford A. Jameson, Ph.D.

Chair, Committee on Science and the Arts Life Science Cluster
Professor, Department of Biochemistry & Molecular Biology
Drexel University College of Medicine
Member of the Committee on Science and the Arts since 1998

BOWER AWARD FOR BUSINESS LEADERSHIP

David M. Rubenstein

Co-Founder and Co-Chairman
The Carlyle Group
Washington, D.C.

CITATION: For embodying the legacy of Benjamin Franklin by blending visionary entrepreneurship with a profound commitment to the public good. Through his remarkable success as co-founder of The Carlyle Group and his passionate dedication to patriotic philanthropy, the arts, health, education, and civic engagement, he exemplifies the values that define the American spirit.

In the National Archives in Washington, D.C., visitors expect to see the Declaration of Independence and the Constitution. Few expect to encounter a much older document—a 1297 Magna Carta—displayed in the same civic setting. That parchment is on long-term loan from David M. Rubenstein, who bought it and placed it where the public can study it. The gesture is characteristic: Ensuring public access through the support of private means.

Rubenstein is best known as the co-founder and co-chairman of The Carlyle Group, the private investment firm he helped launch in 1987. As his career has matured, he has become equally identified with philanthropy, especially what he calls "patriotic philanthropy," large-scale giving aimed at preserving national landmarks and the institutions that steward American history.

His story begins in Baltimore, Maryland, where he was born in 1949 and raised in a modest, working-class household. Scholarships and part-time work opened doors that would otherwise have been closed. He attended Duke University, graduating magna cum laude and joining Phi Beta Kappa, then went on to earn his JD at the University of Chicago Law School, where he served as an editor of the Law Review.

Early on, Rubenstein's ambition was public service. After practicing law, he worked in Washington as chief counsel to a U.S. Senate Judiciary subcommittee and then joined the Carter administration as Deputy Assistant to the President for Domestic Policy. The experience gave him a close-up view of how government decisions are made. After leaving the White House, he returned to private practice in Washington before co-founding Carlyle.

Investing, restructuring, and building businesses through Carlyle helped make Rubenstein a prominent figure in the global private equity industry. But his public imprint is not only in deal-making. It is also in what his success allowed him to underwrite: cultural infrastructure, civic memory, and the idea that some parts of a nation's story should be available to everyone, not hidden behind paywalls or tucked away in private collections.

That philosophy shows up most visibly in the restoration and repair of national landmarks. Rubenstein has been a major supporter of projects tied to the Washington Monument and the Lincoln Memorial, among other national sites. His personal giving totaling more than $1 billion makes him one of the largest individual contributors to a number of landmark initiatives. It is also visible in museums and archives, places where democracy is kept not just in law, but in material form. The National Archives' "Records of Rights" exhibition, housed in the David M. Rubenstein Gallery, makes civic texts tangible to the public; the loaned Magna Carta is its striking anchor. Rather than treating historical artifacts as trophies, Rubenstein has emphasized long-term loans that put rare materials into public institutions. The point is not simply preservation. It is circulation: documents and objects made available for students, scholars, and citizens.

Rubenstein's institutional leadership mirrors that same dedication to stewardship. He has chaired boards at organizations that shape civic and cultural life, including the Council on Foreign Relations and the National Gallery of Art. He is also an original signer of the Giving Pledge, aligning himself with the principle that a substantial share of private wealth should be directed to philanthropic purposes. This commitment is made clear not only in his patriotic philanthropy but in the hundreds of millions of dollars he has donated to higher education, health initiatives, and the performing arts.

In recent years, Rubenstein has built a second kind of public platform: conversation. Through "The David Rubenstein Show: Peer-to-Peer Conversations," he conducts long-form interviews with leaders across business, government, and culture, treating biography as a source of practical lessons about judgment, responsibility, and power. Long before the television cameras, he was already doing a version of this work as president of the Economic Club of Washington, D.C., where he has conducted more than 130 public interviews. His books extend his trademark approach, using interviews and American history to explore leadership, investing, and the presidency. He is the author of five books, including The American Story, How to Lead, and How to Invest, and he hosts related series on Bloomberg and PBS.

In January 2025, Rubenstein received the Presidential Medal of Freedom, the nation's highest civilian honor, an acknowledgment that his influence has reached well beyond finance into the cultural and civic institutions he has supported. Even with a national profile, Rubenstein's story keeps circling back to Baltimore. In 2024, an ownership group led by Rubenstein acquired control of Major League Baseball's Baltimore Orioles, making a Baltimore native the principal owner of one of the city's most visible institutions. It was a business transaction, but also a homecoming, an emblem of how his life has moved between private achievement and public place.

David M. Rubenstein was born and raised in Baltimore, Maryland. He earned a B.A. from Duke University and a J.D. from the University of Chicago Law School before a storied career in government, law, and finance.

Previous Recipients of the Bower Award for Business Leadership

1990/91	JAMES EDWARD BURKE
1991/92	DAVID TODD KEARNS
1992/93	ARNOLD O. BECKMAN
1993/94	ROBERT W. GALVIN
1994/95	JOAN GANZ COONEY
1995/96	DAVID PACKARD
1997	GEORGE B. RATHMANN
1998	JOHN C. DIEBEL
1999	P. ROY VAGELOS
2000	WILLIAM J. RUTTER
2001	IRWIN MARK JACOBS
2002	GORDON E. MOORE
2003	HERBERT D. KELLEHER
2004	RAYMOND V. DAMADIAN
2005	ALEJANDRO ZAFFARONI
2006	R. E. (TED) TURNER
2007	NORMAN R. AUGUSTINE
2008	FREDERICK W. SMITH
2009	T. BOONE PICKENS
2010	WILLIAM H. GATES III
2011	FRED KAVLI
2012	JOHN T. CHAMBERS
2013	MICHAEL S. DELL
2014	WILLIAM W. GEORGE
2015	JON M. HUNTSMAN
2016	PATRICK SOON-SHIONG
2017	ALAN R. MULALLY
2018	ANNE M. MULCAHY
2019	INDRA K. NOOYI
2021	ARTHUR D. LEVINSON
2022	STÉPHANE BANCEL, ALBERT BOURLA, AND ALEX GORSKY
2023	KENNETH C. FRAZIER
2024	LISA SU
2025	JAMIE DIMON

Prior to 1997, awards were designated by the year of nomination. Subsequently, awards were identified by the year of presentation.

LAUREATE SPONSOR:

Michael Useem, Ph.D.

Chair, Bower Award for Business Leadership Selection Committee
William and Jacalyn Egan Emeritus Professor of Management
Faculty Director, Center for Leadership and McNulty Leadership Program
Wharton School of the University of Pennsylvania

BENJAMIN FRANKLIN NEXTGEN AWARD

Josh Alman, Ph.D.

Associate Professor of Computer Science
Fu Foundation School of Engineering and Applied Sciences
Columbia University
New York, New York

CITATION: For contributions to theoretical computer science through the design and analysis of algorithms for fundamental operations that are routinely performed in all fields of science and engineering.

What happens when you press "play" on a song, ask your phone to clean up a blurry photo, or watch an AI tool spin words into a paragraph? It feels instantaneous. Effortless. But behind that ease is a relentless drumbeat of tiny operations repeated at staggering scale: combining long lists of numbers, converting information from one form into another. The best way to picture it is not as "intelligence," but as work—billions upon billions of mechanical steps. If you can make those steps faster, you don't just improve one app. You improve whole categories of technology: medical imaging, climate modeling, data compression, machine learning, and a slew of others.

That is the kind of problem that motivates theoretical computer scientist Josh Alman. His work sits at the intersection of algorithm design and complexity theory. He develops faster methods for fundamental tasks, and he also proves when popular strategies hit their limits for speed improvement. Both contributions matter. In fast-moving fields, knowing which roads are dead ends is as valuable as finding a new shortcut.

Two threads run through Alman's research, each a mathematical operation Alman puzzles over in abstraction. Practical implementation happens elsewhere, in industry venues that turn the base math into code and hardware protocols.

The first is the family of Fourier-style transforms. These computational tools reorganize information, so patterns become easier to detect and manipulate. The second is matrix multiplication, the operation behind many of the most computationally expensive parts of scientific computing, machine learning, video, 3D graphics, and many more computational tasks we encounter daily. Alman has advanced both, and he has helped clarify the limits that govern how efficient they can be.

Fourier transforms are often described as a translation of data. A sound wave, an image, or a sensor signal can be represented in different "coordinates." Some computing tasks, like manipulating images and audio, become dramatically easier with the right representation. The Fast Fourier Transform (FFT) is the best-known algorithmic workhorse in this area. It makes said computational efforts efficient enough to be used everywhere, from audio compression to signal processing to numerical simulation. Alman's work increases the efficiency of FFT, making it faster and computationally cheaper with improvements to its algorithmic framework.

The same holds true for Matrix Multiplication. Like FFT, the underlying principle is a translation of data. Specifically, two or more sets of numbers represented as matrices—grids, much like spreadsheets—are combined through the matrix multiplication algorithms into a new matrix of data. Matrix multiplication sounds like a textbook topic until you notice how often it is the bottleneck in many modern computing tasks. Matrices are a convenient way to represent systems with many interacting variables: graphics pipelines, simulations, optimization problems, the linear-algebra at the heart of many machine-learning models, and more.

For decades, computer scientists have searched for ways to multiply large matrices faster. Speed up matrix multiplication, speed up many computing tasks. Progress comes from finding unexpected algebraic structure, ways to reorganize the computation so it uses fewer basic multiplications. Alman and collaborators have produced results that sharpen the best-known approaches for fast matrix multiplication, expanding the set of techniques the field can use to hunt for still-faster methods.

Just as importantly, Alman has contributed “barrier” results: proofs that certain widely used approaches cannot achieve greater efficiency. These results help explain why long-running lines of attack have stalled, and they prevent the field from over-investing in refinements that will never deliver the hoped-for gains. In a discipline where improvements can take years of work and move by small increments, that kind of clarity accelerates progress.

Josh Alman’s work is a reminder that the future is often decided by the invisible. The technologies that feel most dazzling rest on foundational operations repeated at immense scale. When those operations become more efficient—or when researchers gain clarity about which routes are worth pursuing—entire fields benefit. By advancing our understanding of faster matrix multiplication, refining the deep toolkit around Fourier-style transforms, and illuminating both the opportunities and the limits in this landscape, Alman is helping to redraw the practical speed limits of computation. And in an era when science, engineering, and discovery increasingly run through computation, that kind of progress is not merely technical. It is enabling, making more of the future feasible.

Josh Alman is based in New York City, where he is a faculty member in computer science at Columbia University. He earned a B.S. in mathematics from the Massachusetts Institute of Technology (MIT), an M.S. in computer science from Stanford University, and a Ph.D. in computer science from MIT. He previously held a Michael O. Rabin postdoctoral fellowship in theoretical computer science at Harvard University.

Josh Alman's Laureate Legacy

The laureate legacy recognizes previous laureates connected to the current laureate by a shared intellectual thread.

1979	SEYMOUR R. CRAY
1988	DONALD ERVIN KNUTH
2004	RICHARD M. KARP
2008	TAKEO KANADE
2009	RUZENA BAJCSY
2010	SHAFRIRA GOLDWASSER
2025	WILLIAM JAMES DALLY

Please note that the laureate legacy does not represent a comprehensive list of all Franklin Institute medalists.

Learn more about Dr. Alman and his work at “Algorithms and Barriers for Fast Matrix Multiplication” on April 29.

— See page 4 for details.

LAUREATE SPONSOR:

Jeremy Johnson, Ph.D.

Professor of Computer Science
College of Computing and Informatics
Drexel University
Member of the Committee on Science and the Arts since 2005

BENJAMIN FRANKLIN MEDAL IN CHEMISTRY

Geoffrey W. Coates, Ph.D.
Tisch University Professor
Cornell University
Ithaca, New York

11

CITATION: For transformative work at the interface of chemical catalyst design and polymer science leading to novel ways of making biodegradable and recyclable plastics.

A blue recycling bin at the curb carries an optimistic promise: yesterday's packaging will become tomorrow's raw material. Yet, once those bottles, tubs, and films arrive at a sorting facility, optimism collides with chemistry. Many plastics that look similar are made from different molecular ingredients, and some of the most common types refuse to mix. The result is a stream of waste that is difficult to reuse at high quality and a primary reason that most of what we put into our recycling bins ultimately ends up in a landfill. This is the world Geoffrey Coates has spent his career trying to redesign.

Coates builds catalysts and polymer synthesis strategies aimed towards a challenging goal: plastics that work beautifully in daily life, then return to use again without becoming trash.

To see the problem up close, consider two workhorse materials: polyethylene and polypropylene. They are everywhere, from milk jugs and detergent bottles to caps, containers, and flexible packaging. They also tend to travel together from the blue bin to the recycling plant, but they are, in a practical sense, incompatible. When melted into the same stream, polyethylene-rich and polypropylene-rich regions separate rather than blend, producing a weak, brittle material. Even a few percent of one polymer mixed into the bulk of the other—what recyclers often call contamination—can be enough to spoil the final product.

Coates helped change that story by treating mixed plastics like an engineering problem. In a 2017 collaboration with researchers at the University of Minnesota, his team developed a specially designed "multiblock" polymer additive that encourages polyethylene-rich and polypropylene-rich regions to mix. Added in small amounts, it acts like a molecular glue between the two materials, producing a tougher, stronger blend instead of a disappointing compromise.

What makes that idea powerful is that it respects how plastics behave in the real world. Recycling is rarely neat. Bales of material contain variation in grades, dyes, fillers, and histories of exposure to heat and sunlight. A practical solution has to tolerate that messiness. The multiblock "glue" approach points toward something closer to the way metallurgy works, where alloying elements can convert mixtures into useful materials. Coates and colleagues have described this as a path to "plastic alloys" that keep desirable properties while expanding what can be recycled together.

Recycling, though, is only one side of Coates's vision. The other is designing plastics that can be returned to nature or taken apart cleanly at the end of life. Many polymers are durable because their backbones are strong, which is exactly what makes them linger for decades. Coates's work often begins earlier in the life cycle, at the moment a polymer is created, by using catalysts to control structure and therefore control destiny.

In practice, that can mean creating polymers that behave like familiar plastics during use, yet contain built-in "release points" that allow them to be chemically recycled or safely degraded when the time comes. One example from Coates's research community is the pursuit of polyolefin-like materials that incorporate chemically cleavable links, offering a route to break a plastic down into useful building blocks rather than downcycling it into waste materials.

Coates's group and collaborators have published work along these lines, aiming for materials that preserve performance while improving end-of-life options. Coates has also engaged the idea of upcycling, where waste plastics become “feedstocks”—the key ingredients—for new, higher-value chemicals instead of being buried, burned, or mechanically degraded. The point is to stop drilling for new feedstocks, which typically come from fossil resources, when a vast supply is already sitting in landfills and incinerators.

The through line in all of this is Coates's ingenuity with catalysts. A catalyst is a kind of guide for molecules, directing them to connect in one way instead of another. Small changes in those connections can determine whether a polymer becomes tough or flexible, long-lived or degradable, easy to separate or impossible to sort. Coates's career has been defined by harnessing that control for sustainability. It is also why his work has crossed easily from academic chemistry into the real world. He is a scientific co-founder of companies such as Novomer, which uses novel catalysts to produce environmentally responsible polymers and chemicals.

There is a particular kind of hope embedded in Coates's work. It is not the hope that society will simply use less plastic tomorrow. It is the hope that the materials themselves can be redesigned so the best version of plastics does not end as pollution. By finding ways to “weld” mixed commodity plastics into strong new materials, by advancing polymers that are recyclable by design, and by pushing toward biodegradability without sacrificing performance, Geoffrey Coates has helped outline a future in which efficient recycling is no longer aspirational. It is engineered.

Born in Evansville, Indiana, Coates earned a chemistry degree from Wabash College and a Ph.D. in organic chemistry from Stanford, studying stereoselective catalysts. After an NSF postdoctoral fellowship at Caltech, he joined Cornell's faculty in 1997, where he has pursued catalyst-driven polymer science ever since.

Geoffrey Coates's Laureate Legacy

The laureate legacy recognizes previous laureates connected to the current laureate by a shared intellectual thread.

1920	SVANTE A. ARRHENIUS
1966	HERMAN F. MARK
1971	PAUL J. FLORY
1978	MICHAEL SZWARC
1999	WALTER KAMINSKY
2000	ROBERT H. GRUBBS
2001	K. BARRY SHARPLESS
2005	HENRI B. KAGAN
2010	JOANNE STUBBE
2017	KRZYSZTOF MATYJASZEWSKI AND MITSUO SAWAMOTO
2019	FRANCES H. ARNOLD

Please note that the laureate legacy does not represent a comprehensive list of all Franklin Institute medalists.

Learn more about Dr. Coates and his work at “Sustainable Plastics” on April 30.

— See page 4 for details.

LAUREATE SPONSOR:

Klaus H. Theopold, Ph.D.

Professor Emeritus, Department of Chemistry and Biochemistry
University of Delaware
Newark, Delaware
Member of the Committee on Science and the Arts since 2012

BENJAMIN FRANKLIN MEDAL IN CIVIL ENGINEERING

Pedro J.J. Alvarez, Ph.D.

George R. Brown Professor of Civil and Environmental Engineering
Director, Rice WaTER Institute
Rice University
Houston, Texas

CITATION: For pioneering discoveries in environmental microbiology that established the field of environmental nanotechnology and revolutionized pollution remediation, with a major influence on industry standards and governmental policy.

Some of the hardest environmental pollution problems are the ones you can't see. They don't always billow from a smokestack or float down a river in plain view. They move through soil and groundwater, seep toward reservoirs, and enter the systems that carry water through towns and cities. For millions of people across the United States and around the world, protecting clean water means understanding contaminants that travel underground. Environmental engineer Pedro Alvarez has spent his career doing exactly that. Alvarez is the George R. Brown Professor of Civil and Environmental Engineering at Rice University and the founding director of several large-scale water technology innovation programs, including the NSF Engineering Research Center on Nanotechnology-Enabled Water Treatment (NEWT) and the Rice University Water Technologies Entrepreneurship and Research (WaTER) Institute. His work focuses on environmental sustainability through bioremediation of contaminated aquifers, fate and transport of toxic chemicals, water footprint of biofuels, microbial-plant interactions, nanotechnology-enabled water treatment and reuse, and strategies to limit the spread of antibiotic resistance.

Alvarez gravitates toward problems where science can change daily life: cleaner water, healthier communities, and smarter environmental policy. One classic hazard begins at an ordinary place, the gas station. Underground storage tanks and fuel infrastructure have a long history of leaks, and small leaks add up. Across the U.S., leaking underground storage tanks have released millions of gallons of gasoline into the ground over time. Once belowground, gasoline does not simply go away. It partitions into different chemical phases, dissolves into groundwater, and can create plumes that migrate away from the original site. The result is a complicated, layered cancer-causing contamination problem that is difficult to excavate and expensive to pump out.

Alvarez advocated for bioremediation as an innovative solution to the problem—leveraging naturally occurring gasoline-eating microbes as partners in cleanup to transform harmful compounds into less harmful ones. But environmental engineers were baffled by why bioremediation worked at some sites but not others. Alvarez tackled that question with a forensic approach. He helped develop genetic tools, treatment methods, and decision frameworks that enabled the prediction and improvement of bioremediation performance across very different environments. His work clarified when "natural attenuation" is reliable and when intervention is needed, guidance that supports regulators and technicians as they choose between letting biology proceed, stimulating it, or changing course.

Over time, Alvarez broadened his scope to include challenges associated with modern water and wastewater treatment infrastructure. One of the most sobering issues is antibiotic resistance outside of hospitals and clinics. Wastewater treatment plants commonly receive sewage with residual antibiotics, and Alvarez discovered that these treatment systems can serve as breeding grounds for antibiotic resistant bacteria that cause infections that are very difficult to treat. Furthermore, when microbes are killed during disinfection of the treatment plant effluent, fragments of their genetic material can remain biologically active and concentrate in sediments of rivers receiving the discharge. Alvarez identified this as a pathway by which antibiotic resistance genes can be potentially taken up and proliferated by other bacteria, creating reservoirs of resistant bugs in the environment.

Here too, he looked for interventions that fit the real world. Rather than focusing primarily on centralized treatment retrofits, Alvarez's work has advanced water treatment technologies designed for decentralized or distributed deployment, enabling innovative materials and processes to be adapted to and integrated into existing infrastructure without requiring full system replacement. In one example, he and his collaborators designed synthetic microparticles coated with a material that can capture and destroy bacteria and extracellular antibiotic-resistance genes when stimulated by light. After treatment, the microparticles can be filtered out and reused. In Alvarez's nanotechnology work for water treatment, the guiding idea is to use engineered materials to make cleanup and disinfection more efficient, selective, and deployable, with lower chemical and energy requirements. Through NEWT, he has helped advance approaches such as solar-driven photocatalysis to detoxify contaminants and inactivate pathogens, as well as filtration membranes that resist biofouling. These tools are aimed at retrofitting aging infrastructure and enabling modular treatment systems for communities where clean water is hardest to secure.

His work has also ventured into a more unusual but compelling idea: using bacteriophages, which are viruses that naturally infect bacteria, but not humans, as tools for water system hygiene. In a Rice-led study on biofilms, Alvarez and collaborators explored "magnetized" bacteriophages that can be externally guided toward harmful biological agents. It might sound like science fiction, but Alvarez's insights are augmenting biological mechanisms with modern materials to solve modern infrastructure problems.

Alvarez has helped bring visibility to problems that were once literally out of sight. He has shown how pollution behaves when it slips underground, how biology can be mobilized to clean it up, and how emerging risks like antibiotic resistance can be addressed before they become public-health burdens. In a world where clean water is becoming both more precious and more complicated to secure, Alvarez's work saves lives and eases the burden on civil engineers as they build for the future.

Pedro Alvarez's trajectory reflects the international, interdisciplinary nature of environmental engineering itself. Born in Nicaragua and raised largely in Argentina, he earned his bachelor's degree in civil engineering at McGill University and his master's and Ph.D. in environmental engineering at the University of Michigan. From there, he built a career at the University of Iowa and mainly at Rice University that has blended fundamental research with practical applications, mentoring scientists and engineers who carry these tools into government, industry, and academia.

Pedro Alvarez's Laureate Legacy

The laureate legacy recognizes previous laureates connected to the current laureates by a shared intellectual thread.

1946	KARL TERZAGHI
1960	ABEL WOLMAN
1979	G. EVELYN HUTCHINSON
1999	RALPH J. CICERONE
2000	GORDON DANBY AND JAMES R. POWELL
2003	CHARLES H. THORNTON
2006	RAY W. CLOUGH
2006	LUNA B. LEOPOLD AND M. GORDON WOLMAN
2008	WALLACE S. BROECKER
2010	W. RICHARD PELTIER
2011	JILLIAN F. BANFIELD
2013	SUBRA SURESH
2016	SHU CHIEN
2018	ADRIAN BEJAN
2023	DEB NIEMEIER
2025	JOHN W. HUTCHINSON

Please note that the laureate legacy does not represent a comprehensive list of all Franklin Institute medalists.

Learn more about Dr. Alvarez and his work at "Environmental Microbiology and Nanotechnology in Action" on April 29.

— See page 4 for details.

LAUREATE SPONSORS:

Bridget M. Wadzuk, Ph.D.

Professor, Department of Civil & Environmental Engineering
Villanova University
Villanova, Pennsylvania
Member of the Committee on Science and the Arts since 2018

Wenqing Xu, Ph.D.

Professor, Department of Civil & Environmental Engineering
Villanova University
Villanova, Pennsylvania
Member of the Committee on Science and the Arts since 2022

BENJAMIN FRANKLIN MEDAL IN COMPUTER & COGNITIVE SCIENCE

Dedre Gentner, Ph.D.

Alice Gabrielle Twight Professor of Psychology & Education
Co-Director, Northwestern Spatial Intelligence and Learning Center
Northwestern University
Evanston, Illinois

CITATION: For elucidating the unique power of human thought, including its roots in the acquisition and use of language, metaphors, maps, and analogies, and for charting new ways to support and enhance these skills.

What happens when you suddenly get hold of a difficult-to-grasp idea? When you finally "get it?" Science says that flash of clarity often arrives through comparison. Electricity becomes "like" water flowing through pipes. An argument is "like" a tug-of-war. A complex organization becomes a "family tree." According to Northwestern University cognitive scientist Dedre Gentner, what we typically dismiss as figures of speech actually reveal the computational systems of the mind. Our mental computers are constantly running comparisons, borrowing structure from something familiar to make sense of something new.

This is the central tenet of Gentner's body of work, which has revolutionized how cognitive scientists understand the way we learn and reason. We tend to view metaphors and analogies as decoration, when, really, they are evidence of the deep machinery, the mental equipment that helps us piece together an understanding of the world.

For much of cognitive science's history, analogy lived in the "soft" category, useful for teaching, perhaps, but too slippery to study rigorously. Gentner helped change that by treating analogy as a process that can be analyzed, tested, and formalized. In Gentner's structure-mapping theory, the strength of an analogy isn't that two things share the same surface features. It's that they share the same relationships, the same pattern of connections among parts. To better reveal the power of analogy to reveal deep, abstract principles, Gentner has documented the major role that analogy has played in scientific discovery. For example, the French scientist Sadi Carnot (1796-1832), a pioneer of modern thermodynamics, discovered the basic principles of heat engines by means of an extended analogy between heat and water. In 1596, Johannes Kepler used an analogy with light to propose that the sun emits a motive spirit or force that causes the planets' motion. Like the light from a lamp, this motive force spreads and becomes weaker with distance, accounting for why the outer planets move slower than the inner planets. This discovery fed into Newton's fuller explanation of gravity some 80 years later.

Gentner also emphasized something that great analogies have in common: they are not just a list of matched parts. They are systems. A strong analogy carries an interlocking web of relationships—cause and effect, constraints, hierarchies, and feedback. This is why the best comparisons don't merely help you remember; they help you predict. If the structure holds, you can reason forward in the new domain using what you already understand in the old one. Once you see analogy as a cognitive tool, a new question emerges: how do we learn to use it? Gentner's analogy research has followed children learning basic concepts as well as adults applying knowledge creatively. One of her key insights is that comparison itself can teach. When learners line up two examples side by side, shared relations become easier to notice. This allows children to extract a more abstract template that can be applied to new situations. In classrooms, even brief prompts to compare can help learners notice relations they would otherwise miss. The language we use with children aids in this process. When children hear the same word applied to two different things, they naturally compare them, and in so doing they can discover the shared meaning. The word then acts as a way label that meaning. In this way language can make complex relations easier to carry from one context to another. A child who learns the language of "above," "between," "inside," "cause," and "effect" is not merely acquiring vocabulary; they are acquiring handles for relationships. These ideas have become vital underpinnings for a science of learning, in part because they point toward practical ways to support reasoning rather than to simply measure it.

Gentner's influence extends beyond psychology and education into artificial intelligence, because once you can describe a cognitive process precisely, you can begin to build tools that emulate parts of it. Her theory helped inspire the Structure-Mapping Engine (SME), a computational system created with Ken Forbus and other collaborators that implements analogical matching in software. The SME is different from modern AI tools, like large language models (LLMs). Their machinery bears little resemblance to that of the human mind, but the SME, running protocols derived from Gentner's structure-mapping theory, is useful for cognitive simulation. It creates analogies and learns in the same way we do.

In other words, Gentner's work does not only explain human reasoning; it helps make analogy a legitimate target for computation with applications in machine learning.

Her work returns us to something intimate, the way a human mind reaches outward. We are not limited to what we have already seen. We learn by mapping, by carrying structure from the known to the unknown, from the concrete to the abstract. In classrooms, it inspires new teaching methods focused on comparison rather than rote recall. In science, it can mean the leap that turns a puzzling phenomenon into a solvable problem. And in everyday life, it can mean the skill of seeing past surface differences to recognize a deeper pattern that matters. Gentner has helped show that this is not a poetic extra. It is one of humankind's most fundamental powers.

Dedre Gentner was born in San Diego, California. She earned a bachelor's degree in physics from the University of California, Berkeley, did graduate work in physics at the University of Chicago, and then completed a Ph.D. in psychology at the University of California, San Diego. She later joined Northwestern University, where she became a leading figure in both psychology and cognitive science.

Dedre Gentner's Laureate Legacy

The laureate legacy recognizes previous laureates connected to the current laureate by a shared intellectual thread.

1999	NOAM CHOMSKY
2005	ARAVIND K. JOSHI
2006	DONALD NORMAN
2011	JOHN R. ANDERSON
2015	ELISSA L. NEWPORT
2017	MICHAEL I. POSNER
2019	MARCIA K. JOHNSON
2024	JANET F. WERKER

Please note that the laureate legacy does not represent a comprehensive list of all Franklin Institute medalists.

Learn more about Dr. Gentner and her work at "Why We're So Smart: Analogy and Abstraction Drive Human Learning" on April 30.

— See page 4 for details.

LAUREATE SPONSOR:

Nora S. Newcombe, Ph.D.

Laura H. Carnell Professor of Psychology
James H. Glackin Distinguished Faculty Fellow
Temple University
Philadelphia, Pennsylvania
Member of the Committee on Science and the Arts since 2013

BENJAMIN FRANKLIN MEDAL IN EARTH & ENVIRONMENTAL SCIENCE

Karen C. Seto, Ph.D.

Frederick C. Hixon Professor of Geography and Urbanization Science
Director, Hixon Center for Urban Sustainability
Co-Director, Yale Center for Geospatial Solutions
Yale School of the Environment
Yale University
New Haven, Connecticut

CITATION: For pioneering work integrating satellite imagery, modeling methods, and social sciences to analyze the consequences of urbanization, land use, and global environmental change.

From far above Earth, cities announce themselves in patterns: a brightening web of night lights, a hardening edge where pavement replaces field, a widening halo of growth along roads and coastlines. Seen from space, urbanization is not an abstract trend. It is a physical transformation of the land below. Karen Seto has spent her career developing ways to characterize those transformations, track them over time, and measure their effects on the global environment. She is widely recognized as a leading expert on contemporary urbanization and global environmental change, known for combining satellite observations with fieldwork and modeling to understand how urban growth reshapes the planet.

Seto helped make urban expansion visible at global scales, and then helped turn that visibility into forecasts of where growth is likely to occur next. Using satellite remote sensing, she began assembling multi-decade records of urban expansion in the early 1990s, when acquiring imagery was far more expensive and technically demanding than it is today. With NASA's Landsat satellites, she tracked rapidly expanding regions in China, India, and other rapidly urbanizing countries, documenting the type and pace of land changes.

The value is not just a picture. Remote sensing also captures non-visible bands of the electromagnetic spectrum, revealing change that standard photographs miss. These measurements can flag shifts in vegetation, moisture, or surface temperature that sometimes precede conversion from cropland to development. By combining the seen and unseen, Seto has compiled comparable evidence across countries and decades, even where on-the-ground data are limited. Once you can track urban growth consistently, you can start asking the questions that matter most. What happens when a city expands into prime cropland? What happens when it spreads into areas rich in biodiversity? What are the greenhouse gas implications of large-scale urbanization? Seto's research has repeatedly returned to these questions, linking the geometry of urban expansion to real-world consequences in food systems, conservation, greenhouse gas emissions, and climate change.

One of her most influential contributions has been to pioneer global, spatially explicit forecasts of urban expansion. In a widely cited study, Seto and her collaborators produced projections of global urban land-cover change to 2030 and examined direct impacts on biodiversity hotspots and carbon storage. The study was a turning point for the field because it treated urban growth not as a vague demographic headline, but as a mapped, physical phenomenon with predictable pressures in specific places. It also was a turning point for international policy. That shift matters for decision-makers. Her forecasts of urban expansion have been used in UN climate reports as well as UN biodiversity conservation assessments. Planning for growth is fundamentally different when you can see likely future corridors of expansion rather than simply knowing "more people will live in cities."

Forecasting also helps reveal a hard truth about cities, that their footprint can grow faster than their population. A region can become more "urban" without becoming dramatically more crowded, simply by spreading outward in low-density development. Seto helped the world recognize those patterns, including how urban form changes across hundreds of cities and what those shifts imply for infrastructure, disaster response, energy use, and sustainability goals.

In another landmark paper, Seto introduced the idea of "urban land teleconnections," a framework for linking urbanization in one place to significant land and environmental change in distant locations. For instance, when a city expands, forests are felled, quarries dug, refineries expand, sometimes hundreds of miles away. Teleconnections make the hidden couplings legible. They invite researchers and planners to follow the threads of cause and effect across regions. Urbanization is often discussed as something that happens inside a boundary line, but the true footprint of cities extends far beyond city limits through supply chains and demand for food, timber, energy, and building materials.

Just as important, Seto has made her work usable. Her lab curates research data products that allow other scientists to build on these methods, including spatially explicit projections of urban land expansion and associated changes in urban heat exposure. In the modern science of cities, shared datasets are a form of infrastructure. They let researchers compare regions, test interventions, and identify places where small planning choices could have outsized environmental outcomes.

Throughout, Seto's approach has stayed grounded in a specific kind of realism. Satellite imagery is powerful, but it can tempt researchers into thinking the view from space is the whole story. Seto consistently pairs remote sensing with field knowledge and the lived dynamics of urban change. Her work reflects that cities are not just pixels. They are policies, economies, migration patterns, and choices about how people want to live.

In this sense, her contributions provide a new kind of clarity. She helped give the world a reliable way to observe urbanization as it happens, and a credible way to anticipate where it is heading. In a century when urban growth will shape biodiversity, climate resilience, and food security, that clarity is not academic. It is a planning tool for humanity.

Born in Hong Kong and raised in the United States, Karen Seto earned a B.A. in political science from the University of California, Santa Barbara. She completed M.A. and Ph.D. degrees at Boston University, training in international relations, resource and environmental management, and geography, before serving on the faculty at Stanford University and later joining Yale University.

Karen Seto's Laureate Legacy

The laureate legacy recognizes previous laureates connected to the current laureate by a shared intellectual thread.

1912	E. LATHROP AND O. SHREINER
1930	WILLIAM N. JENNINGS
1945	DAVID GILMORE CLARKE
1970	RUTH PATRICK
1974	ARIE JAN HAAGEN-SMIT
1974	JAY W. FORRESTER
1999	RALPH J. CICERONE
2003	NORMAN A. PHILLIPS AND JOSEPH SMAGORINSKY
2006	LUNA B. LEOPOLD AND M. GORDON WOLMAN
2008	WALLACE S. BROECKER
2010	W. RICHARD PELTIER
2013	ROBERT A. BERNER
2015	SYUKURO MANABE
2018	SUSAN TRUMBORE
2019	GENE LIKENS
2021	MONICA TURNER
2025	KATHARINE SUDING

Please note that the laureate legacy does not represent a comprehensive list of all Franklin Institute medalists.

Learn more about Dr. Seto and her work at "Cooling Hot Cities" on April 29.

— See page 4 for details.

LAUREATE SPONSOR:

Laura E. Toran, Ph.D.

Professor Emeritus, Department of Earth and Environmental Science
Temple University
Member of the Committee on Science and the Arts since 2014

BENJAMIN FRANKLIN MEDAL IN PHYSICS

Wendy Laurel Freedman, FRS

John and Marion Sullivan University Professor
Department of Astronomy & Astrophysics
University of Chicago
Chicago, Illinois

CITATION: For scientific investigations that established precision measurements of the expansion rate of the universe, and for leading efforts to make the next generation of these measurements even more precise.

For the latter half of the 20th century, astronomers tried in vain to pin down a number that acts like a master scale bar, that little cartographical ruler icon, on our map of the Universe. Get it wrong, and everything that follows becomes shaky: how big the Universe is, how long it has been expanding, and how quickly it is changing today. The value of what we call the Hubble Constant had been the source of contentious debate since Edwin Hubble's early unsuccessful attempts to measure it based on the state-of-the-art, but ultimately inaccurate, data.

In the 1990s, Wendy Freedman became a central figure in changing that, harnessing the power of what was then arguably the most advanced technology to leave Earth. An observational cosmologist now at the University of Chicago, Freedman led the Hubble Space Telescope Key Project. The aim was to utilize the Hubble Space Telescope to derive precise distances to galaxies, and from those distances, to deliver a definitive measurement of the universe's current expansion rate.

The timing was dramatic. The Hubble Space Telescope had launched in 1990, and almost immediately the mission faced a public crisis: its primary mirror had been ground to the wrong shape, producing blurred images that threatened many of the telescope's most demanding science programs. NASA and its partners responded with an engineering rescue that has since become legend. In 1993, astronauts installed corrective optics during the first servicing mission, effectively giving Hubble "glasses" and restoring its intended sharp vision.

For astronomers chasing faint, faraway targets, that fix was not merely cosmetic. It was essential. Freedman's Key Project depended on Hubble's ability to do something exquisitely difficult: measure precise brightness changes of Cepheid variable stars in other galaxies. Cepheids are stars that rhythmically brighten and dim, and the timing of that rhythm is tied to their intrinsic luminosity. If you can measure the rhythm and compare intrinsic brightness to observed brightness, you can infer distance. The brilliance of the Key Project was not simply using Cepheids but using them as a foundational calibration for multiple other distance-measuring techniques that reach even farther into the universe.

That cross-checking became the project's signature. Rather than betting everything on one rung of the cosmic distance ladder, Freedman and her team used Cepheid distances to anchor several "secondary indicators" that could be applied to galaxies too distant for Cepheids to be easily measured. In practice, this meant building an interlocking chain of measurements, each one tested against the others, so that systematic errors could be identified and squeezed down. The Key Project's final results, published in the early 2000s, delivered a measurement with a clearly stated uncertainty and helped settle a long-running debate that had persisted for decades. What made Freedman's role especially consequential was her insistence that the result had to be earned the hard way: through careful calibration, transparency about uncertainties, and independent paths to the same answer. The Key Project was designed around that philosophy from the start, with an explicit goal of measuring the expansion rate by building redundancy and checks into the method. In other words, it was not enough to produce a number. The project had to produce confidence.

Freedman's story also includes a second act that speaks to how science actually progresses. Once the findings of Freedman's team settled the bigger debate around the Hubble Constant, a more subtle challenge emerged: discrepancies between different modern measurement approaches began to suggest that there might be factors missing from the cosmological model. Freedman responded by helping lead an effort to re-measure the expansion rate using an independent distance route, reducing reliance on Cepheids and testing the ladder with different stellar signposts. Through the Chicago-Carnegie–Hubble Program, she and collaborators have used alternative calibrators, including methods based on older stellar populations, to provide an independent check on the distance scale.

Freedman has also helped shape the field's next big ground-based observatory. From 2003 to 2015, she served as the founding chair of the board of directors of The Giant Magellan Telescope (GMT) project, an international effort to build an extremely large optical telescope at Las Campanas Observatory in Chile. With four times the resolving power as the space-based James Webb Telescope, Freedman hopes the GMT will help detect signatures of life among the stars.

Freedman's legacy is about making the universe measurable. She helped turn the Hubble Space Telescope into a cornerstone for the modern cosmic distance scale. Then she kept going, stress-testing the result with independent approaches and helping design the next generation of observatories that will sharpen our view even further. In a science where the biggest truths can hinge on the tiniest calibration choices, that is a rare and enduring kind of impact.

A native of Toronto, Wendy Freedman earned her doctorate at the University of Toronto and then joined the Carnegie Observatories, where she became director in 2003. In 2014, she joined the University of Chicago as a University Professor, continuing her work using space- and ground-based observatories to refine cosmological distances and the expansion history of the universe.

Wendy Freedman's Laureate Legacy

The laureate legacy recognizes previous laureates connected to the current laureate by a shared intellectual thread.

1935	ALBERT EINSTEIN
1939	EDWIN HUBBLE
1945	HARLOW SHAPLEY
1980	LYMAN SPITZER
1999	JOHN C. MATHER
2001	ALAN GUTH
2009	SANDRA M. FABER
2012	RASHID SUNYAEV

Please note that the laureate legacy does not represent a comprehensive list of all Franklin Institute medalists.

Learn more about Dr. Freedman and her work at "Charting the Cosmos: From Distance Ladders to Precision Cosmology" on April 29.

— See page 4 for details.

LAUREATE SPONSORS:

Jim Napolitano, Ph.D.

Professor of Physics
Temple University
Member of the Committee on Science and the Arts since 2021

Mark Trodden, Ph.D.

Dean, School of Arts & Sciences
Thomas S. Gates Jr. Professor of Physics and Astronomy
University of Pennsylvania
Member of the Committee on Science and the Arts since 2023

AWARD FOR BUSINESS LEADERSHIP

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Harvard Business School

Alex Gorsky
2022 Bower Award for Business Leadership
Johnson & Johnson, Retired

Rajiv L. Gupta
Rohm and Haas Company, Retired
Johns Hopkins Gupta-Klinsky India Institute

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F. William McNabb III
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Chair Emeritus, The Franklin Institute Board of Trustees
West Pharmaceutical Services, Inc., Retired

Anne M. Mulcahy
2018 Bower Award for Business Leadership
Xerox Corporation, Retired

Indra K. Nooyi
2019 Bower Award for Business Leadership
PepsiCo, Retired

Lisa Su, Ph.D.
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AMD

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Perelman School of Medicine, University of Pennsylvania

Daniel J. Rader, M.D.
Perelman School of Medicine, University of Pennsylvania

**Member, Committee on Science and the Arts*

The mission of The Franklin Institute's Committee on Science and the Arts is to sustain the scientific character of The Franklin Institute through the investigation of worldwide scientific and technological achievements and its recommendations for the awarding of Benjamin Franklin Medals, the Benjamin Franklin NextGen Award, and the Bower Award and Prize for Achievement in Science. The Committee maintains high standards for awarding the medals using the following selection criteria:

- The committee carefully selects candidates using a thorough case investigation process to recognize those scientists and engineers who lead their fields, expand knowledge, and serve humanity.
- Individuals must be nominated for an invention, discovery, technological development, or a body of such work reflecting uncommon insight, skill, or creativity on the part of the candidate.
- The work must have significant scientific value or proven utility. It must have provided significant direction for future research, solved an important problem, or provided great benefit to the public.
- Candidates for the award must be living persons.
- The Committee considers individuals from all over the world.

Committee members who become case sponsors represent their nomination cases before the full committee for review and action. Following two successful case presentations, including the review of letters of evaluation solicited from preeminent experts in the field of the case, nominations are forwarded to the Institute's Board of Trustees for final review and approval. During the following spring, medalists are brought together at The Franklin Institute for the annual Awards Ceremony and Dinner and Awards Week celebration of science.

The all-volunteer Committee on Science and the Arts is composed of scientists and engineers from academia and industry. Meeting regularly throughout the year, it has a reputation for diligence and integrity. The committee's work reflects the mission of The Franklin Institute and provides a valuable service to the public and to the scientific community.

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AS TO LIVE WELL."

– Poor Richard's Almanack, 1738