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מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

THE WEIZMANN

INTERNATIONAL MAGAZINE OF SCIENCE & PEOPLE No. 14

Biomedicine and beyond

The Grand Israel National Center for Personalized Medicine at five years

From the President

Dear Friends,

We recently received some excellent news with the release of the Leiden University ranking of scientific research impact: the Weizmann Institute was ranked ninth worldwide, the highest ranking we have achieved to date, and making it the second-highest ranked institution outside of the United States. You can read a more detailed description on page 4.

One of the things we try to do in each issue of Weizmann Magazine is to describe new horizons in science—areas that scientists the world over are exploring—and how Weizmann scientists are uniquely advancing these areas. In this issue, we have taken on quantum computing, among other disciplines. While few of us can imagine our lives anymore without computers, many of us remember life before the digital age. But now a whole new era in computing awaits us—with faster, far more powerful capabilities along with results that will reverberate throughout our lives. Weizmann Institute physicists and computer scientists are among the world leaders in the field of quantum computing.

Our cover story highlights the Nancy and Stephen Grand Israel National Center for Personalized Medicine, which was established in 2012. The Center has, far and away, exceeded all of our expectations in a very short time frame, serving as a national hub to truly advance the bounds of human health. The magazine also gives us the opportunity to serve up stories about our friends and supporters, and in this issue you'll read about another particularly special connection: between the Institute and the Azrieli family of Canada and Israel.

We will also give you a taste of the Global Gathering of the Weizmann Institute, which was held in Boston in June. By "bringing" the Weizmann Institute to Boston, we had the opportunity to celebrate two international hubs of science, Israel and Boston, and I believe we really maximized our learning there with events at Harvard and MIT.

All best wishes,

Prof. Daniel Zajfman
President, Weizmann Institute of Science

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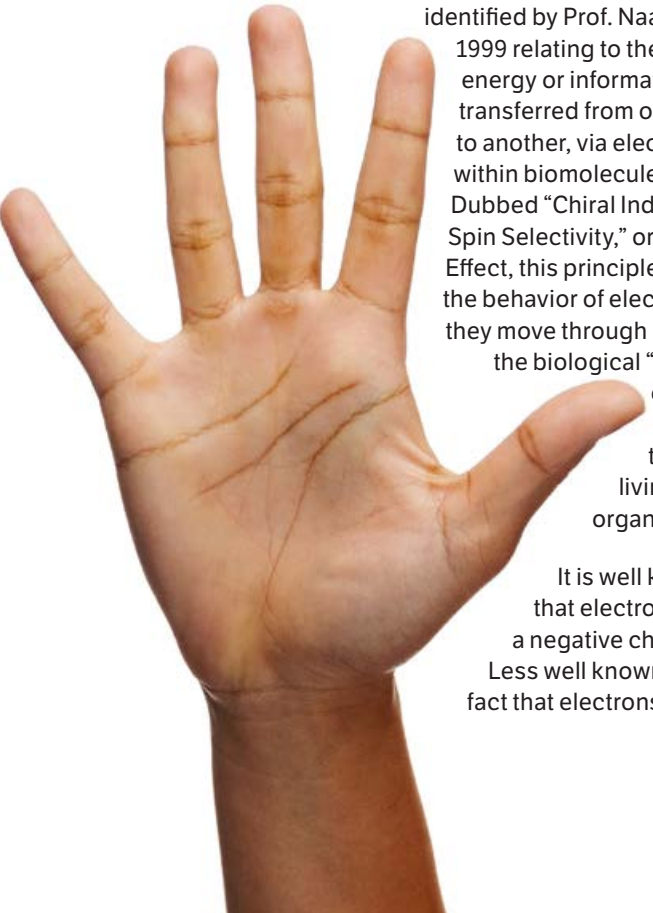
Safer drugs, fewer side effects

Molecular discovery expected to affect industrial practice

Drugs, pesticides, and fertilizers are crucial for our survival. But they may include impurities with harmful side effects for people, animals, and the environment. Now, a discovery by Prof. Ron Naaman of the Department of Chemical and Biological Physics, together with Prof. Yossi Paltiel from the Hebrew University of Jerusalem, has led to a new approach that has the power to make the bio-related products of industrial organic chemistry safer.

Based on an understanding of how electrons move within bio-based molecules like amino acids and proteins, the new wheat-from-chaff approach offers a strategy for "filtering" molecules in order to select those with desired functions, while reducing those that might produce harmful side effects.

This dramatic advance, published in *Science* earlier this year, is rooted in a fundamental property identified by Prof. Naaman in 1999 relating to the way energy or information is transferred from one place to another, via electrons, within biomolecules. Dubbed "Chiral Induced Spin Selectivity," or the CISS Effect, this principle explains the behavior of electrons as they move through proteins—the biological "wires" that conduct electrons through living organisms.



It is well known that electrons carry a negative charge. Less well known is the fact that electrons also have "spin"—angular momentum similar to that of a top, which spins in either a clockwise or counter-clockwise direction. As they move through proteins, these twin properties of charge and spin cause electrons to behave as if they are under the influence of a magnetic field. Structure also plays a role in how the movement of electrons through proteins proceeds: electrons of one spin type are "preferred" over the other, due to the fact that proteins, like most biological molecules, are "chiral" in structure.

Mirror images

A molecule is chiral if it has a symmetry that can exist in two distinct configurations—what scientists refer to as right- or left-handedness—and in which each form is a mirror image of the other. Like the chiral "twist" of the DNA double helix, proteins can appear in two different symmetries, depending on whether they twist to the right or to the left.

As electrons pass through chiral molecules they act as a filter, with "right-handed" molecules favoring the passage of electrons that have one type of spin, and "left-handed" molecules favoring electrons

Scan the QR code to see an animated video about the CISS Effect, and how it enables a future of safer drugs, pesticides, and fertilizers.

Science Briefs

whose spin proceeds in the opposite direction. This discovery of the structural characteristics that control electron transfer through chiral molecules—and which provide a "blueprint" for how biological molecules might someday be incorporated into electronic systems—is Prof. Naaman's CISS Effect.

Now, working with Prof. Paltiel, Prof. Naaman has developed a breakthrough approach that combines the CISS Effect with a magnetic substrate to separate safe and unsafe molecules. The generic and inexpensive method will make it possible for pharmaceutical companies to create drugs with fewer unwanted side effects.

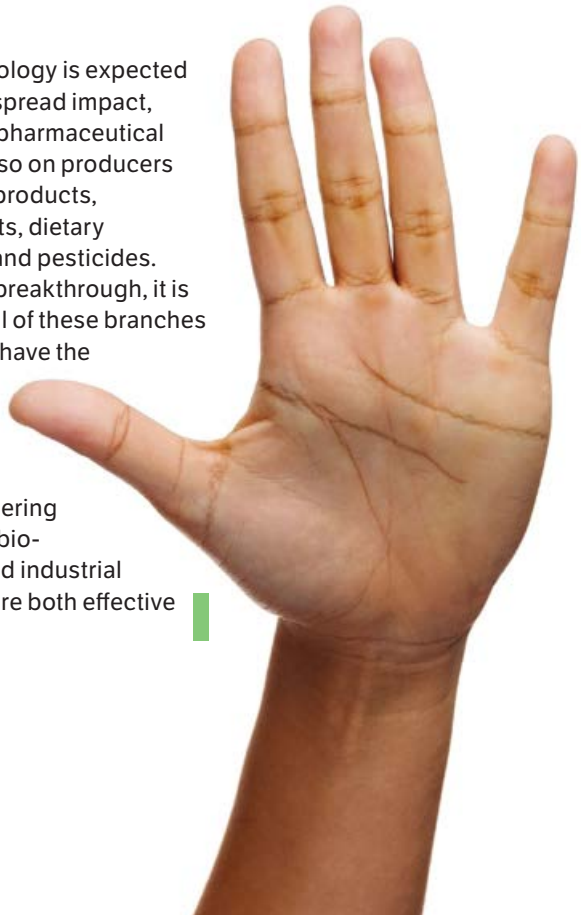
Prof. Ron Naaman

The need to separate chiral molecules into right- and left-handed versions has long been recognized by the pharmaceutical industry. In the most prominent example, a chiral drug called thalidomide, designed in the 1950s to ease morning sickness in pregnant women, was found to provide nausea relief, but the "left-handed" version of this same molecule caused horrible birth defects. Separation of chiral molecules, however, is complex and costly. Despite FDA recommendations, only 13 percent of chiral drugs are currently separated.

Prof. Naaman and Prof. Paltiel, who have been working on the separation problem for a decade, recently came up with a solution: magnets.

"Chiral molecules interact with a magnetic substrate and line up according to the direction of their handedness, because the 'left' molecules interact better with one pole of the magnet, while the 'right' molecules interact better with the other pole," Prof. Naaman explains. "This allows chemical manufacturers to keep the good molecules and discard the bad ones that cause harmful side effects."

The new technology is expected to have a widespread impact, not just on the pharmaceutical industry, but also on producers of agricultural products, food ingredients, dietary supplements, and pesticides. Thanks to this breakthrough, it is believed that all of these branches of industry will have the ability to separate safe and unsafe molecules, ushering in a new era of bio-molecule-based industrial products that are both effective and safe.



Weizmann at #9 on prestigious Leiden ranking

The Leiden University ranking for 2018, which measures the impact of scientific research, placed the Weizmann Institute at number nine internationally out of 800 institutions, making it the second-highest ranked institution outside of the United States. This is the highest ranking ever achieved by the Weizmann Institute in the annual Leiden survey, which is conducted by the Centre for Science and Technology Studies at Leiden University in the Netherlands. In the previous survey, the Institute was ranked tenth.

The Leiden survey is based mainly on the ratio of citations to published papers—a reflection of how other scientists take note of and value Weizmann research—rather than on the quantity of publications or any other factors. "This is a very worthwhile ranking because it focuses on the impact of scientific publications from Weizmann scientists—and clearly the impact is increasingly high," says Prof. Daniel Zajfman, President of the Weizmann Institute.

A decade ago, the Institute placed nineteenth on the Leiden survey. In the 2018 ranking, 20 percent of scientific articles published by Weizmann Institute scientists were in the top 10 percent of the most influential publications. This is an indication both of the depth of talent at the Institute and the importance of their publications. For the time period in which the assessment was done (2013-2016), more than 2,500 articles by Weizmann scientists received more than 33,000 citations.

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🇺🇸	10.	University of California—San Francisco

Adelis Brain Research Prize awarded

The 2018 Adelis Brain Research Prize for groundbreaking research by a young neuroscientist has been awarded to Dr. Ofer Yizhar of the Weizmann Institute.

The Adelis Foundation—established by the late Mr. André Cohen Deloro to support academic excellence in Israeli medical and scientific research—launched the Adelis Brain Research Prize in 2015. This award, accompanied by a $100,000 grant, will support Dr. Yizhar's groundbreaking research in optogenetics—a technology that renders individual, highly specific brain cells photosensitive and then activates those cells using flashes of light.

Dr. Yizhar, a member of the Department of Neurobiology, uses optogenetic techniques to examine the prefrontal cortex—a region of the brain that plays important roles in many higher order processes, including memory, emotional regulation, behavioral control, and social behavior. Problems in prefrontal function are associated with various psychiatric disorders, including depression, schizophrenia, autism, and obsessive-compulsive disorders.

Dr. Yizhar's proposal described a project in which optogenetic techniques will be used to elucidate the brain mechanisms that mediate the emotional and cognitive effects of loneliness.

Trees of life

A new study piloted by Weizmann Institute scientists suggests that planting semi-arid forests in two previously neglected areas—in Africa's Sahel Region and in North West Australia—could significantly counteract human-induced global warming. The research, published in *Nature's Scientific Reports,* showed that trees in these regions could absorb an amount of carbon equal to 10 percent of the world's uptake and cool the Earth considerably within around six years.

Prof. Dan Yakir, from the Department of Earth and Planetary Sciences, and former PhD student Dr. Gil Yosef, explored the question of what the effects might be if a forest like Israel's Yatir Forest was planted in a much larger setting. Using a global climate model designed by University of Miami scientists, they saw that not only could such afforestation produce local cooling, but that the effects could also extend more broadly to the regional climate.

The main reason for this phenomenon, according to Prof. Yakir, is that trees in semi-arid forests are typically excellent "water miners" and have particularly deep roots. These trees reach down into the ground to pull up more water and evaporate it through their leaves, making the surface measurably cooler. In turn, cooler surface temperatures trigger a chain of surface and atmospheric events that ultimately enhance both precipitation and carbon uptake.

While afforestation in the Sahel and in North West Australia could theoretically give rise to an enormous carbon sink, accomplishing such a task is probably easier said than done, Prof. Yakir acknowledges.

"But if this is also done in other places, the effects will add up," he says. "There is no 'silver bullet' in dealing with climate change. We need everything at our disposal."

EMET Prize awarded to Weizmann chemists

Two Weizmann Institute chemists, Prof. Leslie Leiserowitz and Prof. Meir Lahav, have received the A.M.N. Foundation's prestigious EMET Prize, which recognizes far-reaching academic achievements that significantly contribute to society. Profs. Leiserowitz and Lahav, both emeritus members of the Department of Materials and Interfaces, earned the award just two years after winning the Israel Prize in chemistry and physics.

The two professors are being recognized for elucidating the chemical mechanisms behind the self-assembly of chiral structures—structures containing molecules that are mirror images of each other. Enabling scientists to understand these critical natural processes, their discoveries have paved the way for additional breakthroughs in chirality (see story on Prof. Ron Naaman, page 2) and helped provide the building blocks for future drug development.

L-R: Prof. Leslie Leiserowitz and Prof. Meir Lahav

Born in Johannesburg, South Africa in 1934, Prof. Leiserowitz earned his PhD in solid-state chemistry at the Weizmann Institute in 1965. Prof. Lahav was born in Sofia, Bulgaria, and received his PhD from the Institute in the same field, in 1967.

From photosynthesis to cancer therapy

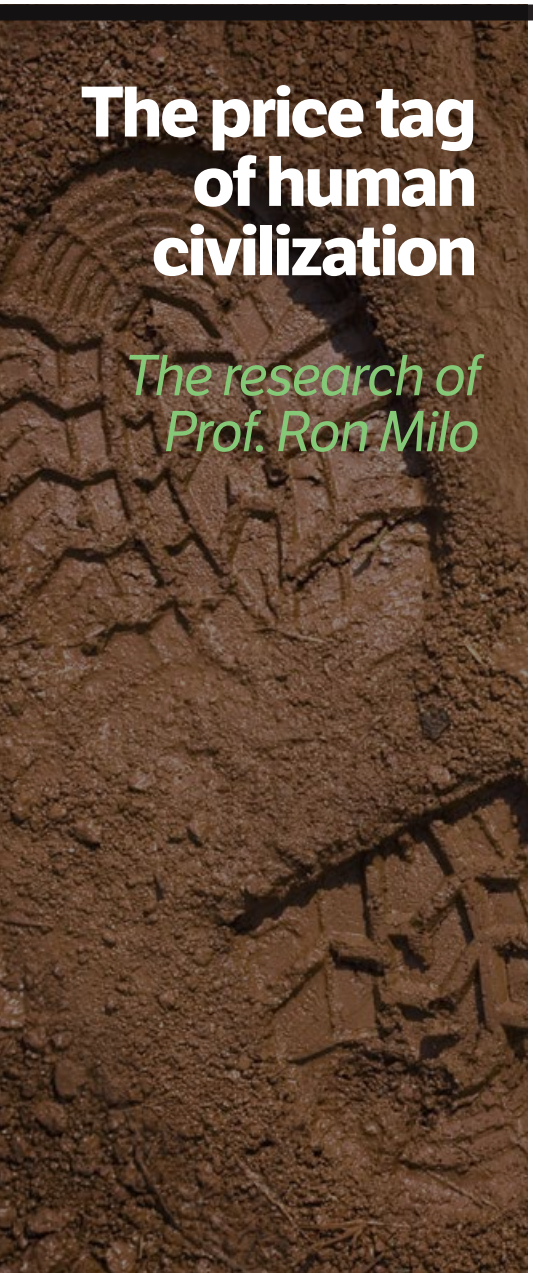
The Weizmann Institute hosted a conference in May in honor of Prof. Avigdor Scherz's 70th birthday, highlighting the plant scientist's revolutionary work with the late Prof. Yoram Salomon that applied insights in photosynthesis to cancer therapy. The scientists' research led to the development of Tookad® Vascular-Targeted Photodynamic therapy (VTP), an anti-cancer drug that is activated at the site of a tumor through exposure to a certain wavelength of laser light.

The therapy has been approved in Mexico and Europe for the treatment of prostate cancer and is in clinical trials for a handful of other cancer types at Memorial Sloan Kettering Cancer Center in New York City.

Also in attendance was Alan Siegel of the Thompson Family Foundation, which sponsors Prof. Scherz's research and is also supporting an extensive collaboration between Sloan Kettering and Cold Spring Harbor Laboratory in New York.

Prof. Avigdor Scherz

Prof. Scherz, of the Department of Plant and Environmental Sciences is now working on combining Tookad®-based treatment with immune modulation, with the goal of counteracting errant immune system activity that protects malignant tumors and promotes cancer progress.



The price tag of human civilization

The research of Prof. Ron Milo

While humans make up just a tiny fraction—only 0.01 percent—of the mass of all living things, we are responsible for a hefty amount of destruction across other species.

Human activity has caused a decline in the total biomass of wild mammals—both marine and terrestrial— by a factor of six, or over 80 percent, since the dawn of civilization, according to a new Weizmann Institute-led study. At the same time, the total mass of mammals has increased about fourfold, due to the vast uptick in the biomass of humanity and associated livestock. Meanwhile, the total plant biomass has declined twofold since the emergence of people on the planet due to the cutting down of forests.

The study, recently published in the *Proceedings of the National Academy of Sciences,* includes a census of the approximately 550 gigatons of carbon (Gt C) biomass distributed among all kingdoms of life. Performed by PhD student Yinon Bar-On from Prof. Ron Milo's laboratory in the Department of Plant and Environmental Sciences, in collaboration with Caltech Prof. Ron Phillips, the research provides a holistic view of the biosphere's composition while characterizing patterns according to taxonomic categories, geography, and nutrition. To assemble the census, the scientists conducted extensive analyses based on hundreds of existing studies.

While plants comprise about 450 Gt C of the total global biomass, humans make up a staggeringly low 0.06 Gt C—a ratio of 7,500 to 1, despite our enormous impact.

"Over the relatively short span of human history, major innovations, such as the domestication of livestock, the adoption of an agricultural lifestyle, and the Industrial Revolution, have increased the human population dramatically and have had radical ecological effects," the authors observe. "The impact of human civilization on global biomass has not been limited to mammals but has also profoundly reshaped the total quantity of carbon sequestered by plants."

A molecule behind anorexia

Prof. Alon Chen

In a counterintuitive finding, a pregnant mother's stress may actually reduce her female fetus's likelihood of developing anorexia later in life, according to a new study by the Weizmann Institute's Prof. Alon Chen.

"It seems that stress during pregnancy actually 'immunizes' the offspring against anorexia," says Prof. Chen, of the Institute's Department of Neurobiology.

Scientists had previously linked anorexia, which is much more prevalent among females than males, to stress factors in early life. At the same time, research in Prof. Chen's lab revealed a connection between stress during pregnancy, messages passed from mother to fetus, and eating disorders. However, in contrast with their initial predictions, the researchers found that female mice born to mothers that had experienced stress during pregnancy were actually *less* likely to display anorexic tendencies when they reached puberty.

The scientists detailed their surprising findings in a recent *Nature Communications* article, led by Dr. Mariana Schroeder, a former postdoctoral fellow at the Weizmann Institute and currently a project leader at the Max Planck Institute of Psychiatry, working in collaboration with Prof. Chen. Honing in on the placenta, they identified a specific mechanism through which certain microRNA molecules—called miR-340—are able to mediate a fetus's future vulnerability to anorexia. When pregnant mothers experienced heightened stress, the placenta reduced the amount of miR-340 molecules reaching female fetuses, who were in turn less likely to experience the eating disorder.

The researchers then overexpressed miR-340 in mice to test their influence on anorexia development, and found that the rates of anorexia jumped dramatically: from 40 percent to 70 percent in females, and from 10 percent to 50 percent in males. In utero, females are typically exposed to about 10 times more miR-340 than males.

This is the first time that scientists have identified a potential mechanism of gestational programming behind anorexia development.

The science of extreme weather

Dr. Shira Raveh-Rubin

Extreme weather presents fascinating questions for a climate scientist. What triggers intense storm systems? How are they formed? What is their contribution to the overall climate? How can their paths and impact be predicted? Dr. Shira Raveh-Rubin is intrigued by such questions about the science of weather and climate, especially at the extremes.

With thousands of years of human activities surrounding it, the Mediterranean is a crucible for the study of climate change; it is also highly sensitive to changes in climate. Extreme weather—including heavy precipitation and flash flooding during the fall season, strong winds and waves in the winter, and heat waves and droughts accompanied by forest fires in the summer—regularly affect the Mediterranean region, causing heavy damage. By combining case studies of highly destructive storms with an analysis

New Scientists

of detailed and long-term weather and climate data, Dr. Raveh-Rubin, of the Department of Earth and Planetary Sciences, hopes to improve both weather forecasting and global climate models.

Residents around the Mediterranean are so intimately familiar with the strong, seasonal winds of the region that they have given them colorful names over the centuries: the powerful Mistral that blows near the Alps; the Tramontane that howls through Southern France; the hot, dry Sirocco from the Sahara that can reach hurricane speeds in North Africa and southern Europe; and the hot, dusty Hamsinim that can blanket Israel and the Middle East.

Dr. Shira Raveh-Rubin

Somewhere over the rainbow, skies are blue

With global warming and the growing intensity of violent storms—from tornados to hurricanes to cyclones—and droughts now of acute concern worldwide, Dr. Raveh-Rubin's research comes at a critical moment. She will lead her new group at the Weizmann Institute in studying these kinds of weather systems and their dynamics. In collaboration with a number of international science teams, her group will work with huge global meteorological datasets that combine models and observations collected over recent history, and develop new diagnostic tools for understanding specific features of weather systems. She will focus on the highly destructive cyclonic storms that often leave a trail of devastation and transport moisture and pollutants across long distances. Her ultimate goal is to better identify the factors and mechanisms that determine the location, intensity, and frequency of climate extremes such as intense droughts, floods, heavy precipitation events, and dangerous storm systems.

"Weather, climate, and the global water cycle know no national boundaries, so research in this area will contribute, I hope, to worldwide efforts to understand both short-term weather and long-term climate change," says Dr. Raveh-Rubin, who completed her BSc in atmospheric sciences with a minor in physics in 2004, and her MSc in atmospheric sciences in 2006, both *cum laude* at the Hebrew University of Jerusalem. She completed her PhD at the Weizmann Institute in 2012 under the direction of Prof. Brian Berkowitz in the Department of Environmental Sciences and Energy Research (now Earth and Planetary Sciences). She was a postdoctoral fellow at the Institute for Atmospheric and Climate Science, ETH Zurich.

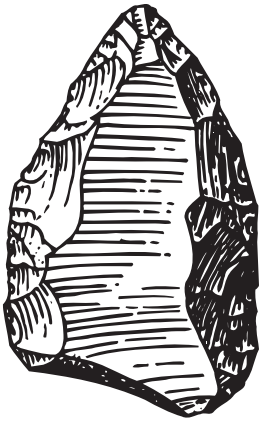
Her academic and professional honors include an excellence award for new students at the Earth Sciences Institute at the Hebrew University in 2001, the Schindel Prize for Excellence in MSc research there in 2005, Rieger-JNF fellowships for environmental studies in 2008 and 2011, a Ministry of Science and Technology excellence fellowship for the advancement of women in science in 2010-2011, and the Otto Schwarz Memorial Graduate Scholarship at the Weizmann Institute in 2012. She gave the keynote address at the fifth European storms workshop (STORMEx) in Bern, Switzerland, in 2015.

"I always loved solving puzzles, uncovering the pieces, and seeing the picture they make," she says. "I also like the intimate feeling of small discoveries that reveal something special just to me—at first—before making their way out to the community and the public. I am fortunate to study questions that can be seen and felt in our everyday experiences, and perhaps arrive at insights that can improve peoples' lives."

Materials of the earth

Meet archaeological biochemist, Dr. Filipe Natalio

Dr. Filipe Natalio grew up near the beach and has been riding a wave of water-related discoveries ever since. How then did this investigator—who earned his doctorate at the University of Mainz, Germany, and also trained in Italy, China, and the Netherlands, as well as his native Portugal—become fascinated with the dry stone tools left behind by our prehistoric, desert-dwelling ancestors? As befits any introduction to a new member of the Weizmann Institute's Scientific Archaeology Unit, getting to the answer to this question requires a bit of digging.



Dr. Natalio studies prehistoric stone tools—treasures of the land that may elucidate the behavior of species, like *homo erectus*, who pre-dated modern humans. But he began his career studying treasures of the sea: marine sponges. His work focused on spicules—microscopic fibers that give deep-sea sponges strength and flexibility, and have unique optical properties. "These needle-like fibers," he says, "are a window into 600 million years of evolution."

Taking a cue from nature—but working at a faster pace—Dr. Natalio was a postdoc when he used sponge proteins to synthesize self-assembling spicules that were strong and flexible enough to use as optical waveguides. This work followed another nature-inspired achievement, in which nanoparticles of Dr. Natalio's design provided an environmentally friendly solution to a difficult maritime challenge: biofouling.

Marine biofouling is the colonization of microorganisms on surfaces directly exposed to seawater, like ships' hulls. Biofouling leads to increased drag, which, in turn, causes an expensive increase in fuel consumption. With his postdoctoral advisor, Dr. Natalio designed a nanoparticle-enriched paint that prevents biofouling by triggering a bleaching process on the hull surface. This approach, now patented, is being developed by the German chemical company BASF.

Nanotechnology and water are central to another, more current, investigation of his: the use of plants as "factories" for manufacturing novel materials. Growing cotton plants in water, Dr. Natalio has demonstrated how nanoparticles can endow plants with different colors, or even properties like fluorescence and magnetism—without genetic modification, using natural biochemical pathways that evolved over thousands of years.

This juncture between plant science and materials helps explain Dr. Natalio's career shift, toward a focus on the ancient world. Inspired by his love of water—as well as the work of his brother, an archaeologist—Dr. Natalio traveled to the Amazon River to examine how, 5,000 years ago, precolonial societies incorporated spicules (in this case tree sponge needles) into the clay used for fashioning pots, thereby producing ceramics with superior mechanical properties.

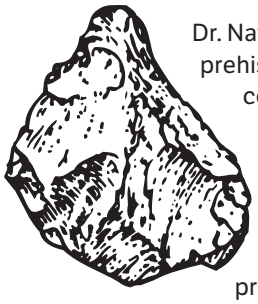
"New technologies not only help people—they change behavior," says Dr. Natalio. "Amazonian potters were the first known to employ biological materials to generate composites with enhanced fracture resistance and high stiffness. It's fascinating to see how this technology, which spread from the riverbed to communities further inland, changed how people lived."

"Stone tools are amazingly interesting," Dr. Natalio says. "It's hard enough to explain human behavior when the humans we're studying are alive. Solving the behavior of our long-dead, human-like ancestors—now that's a challenge!"

Dr. Filipe Natalio

Joining the Weizmann Institute, first as a visiting scientist and then as a faculty member, has changed Dr. Natalio's life, as well as that of his wife, who has joined the Department of Structural Biology as a postdoctoral researcher. Dr. Natalio was recruited to the Kimmel Center for Archaeological Science by its founding director, Prof. Steve Weiner of the Department of Structural Biology.

"With his knowledge of chemistry, materials science and biology, as well as the fact that he had carried out some fascinating archaeological research, I recognized that Filipe could be an excellent candidate for the Kimmel Center," Prof. Weiner says. Prof. Elisabetta Boaretto now heads the Center.



Dr. Natalio's current work focuses on prehistoric stone tools, a topic that combines the physics of fracture geology, and chemistry with social behavior and physical anthropology. He will be using atomic-level imaging to tease out the chemical and physical properties of the stone tools, as well as single-cell analysis to study trace organic materials. He also plans to employ artificial intelligence—computer vision and machine learning technologies capable of linking specific artifacts to individual, prehistoric tool makers—to make inferences about behavior, migration patterns, and inter-community cultural transmission.

"Stone tools are amazingly interesting," Dr. Natalio says, while shifting the substantial weight of a 1.2-million-year-old flint hand axe from one palm to the other. "It's hard enough to explain human behavior when the humans we're studying are alive. Solving the behavior of our long-dead, human-like ancestors—now that's a challenge!"

The Grand Center at five years

Joint projects across Israeli hospitals and institutions advance biomedicine

Cover Story

12–13

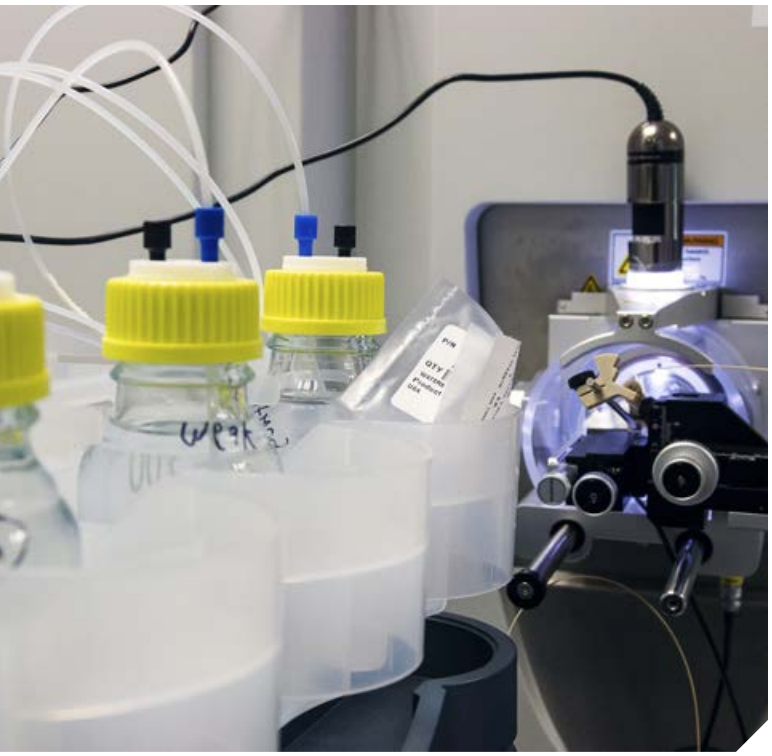
When the Nancy and Stephen Grand Israel National Center for Personalized Medicine was founded in 2012, it set out to bring together a diverse group of scientific talents under one roof and to equip them with the cutting-edge tools needed to move medicine forward. It came to life thanks to major support from Nancy and Stephen Grand of San Francisco and other visionary donors (see page 18).

Initiated by the Weizmann Institute, the Grand Center (also known as the G-INCPM) was designed to create a national resource where all of Israel's biomedical researchers could collaborate with teams of experts to advance the basic research needed to create new drugs and therapeutic approaches for treating and curing diseases. These areas of expertise are divided into the Grand Center's four "pillars": the Crown Genomics Institute, the de Botton Protein Profiling Institute, the Ilana and Pascal Mantoux Bioinformatics Institute, and the Maurice and Vivienne Wohl Drug Discovery Institute. The Wolfson Family Charitable Trust of the UK gave a visionary gift to support the renovation and construction of the former Solar Tower, which now houses the G-INCPM. Rounding out the Grand Center's institutional resources are the Shapell Institute—which supports IT infrastructure—and the Institute for Medicinal Chemistry.

The result is a fully integrated enterprise that harmonizes the essential functions needed to speed up the translation of scientific discovery from the lab into the clinical arena.

Now celebrating its fifth anniversary, the Grand Center boasts an outstanding level of productivity, with 596 projects completed in 2017— a 20 percent increase over the total projects completed the previous year, and continuing the trend of rapid year-over-year growth that has characterized this Center since its inception.

The Center's growing impact is seen in an important benchmark reached this year, with the number of projects completed in collaboration with scientists and clinicians outside of the Weizmann Institute (333) exceeding the number of projects performed with Weizmann collaborators (268). During 2017, Grand Center experts collaborated with researchers at the Hebrew University of Jerusalem, Bar-Ilan University, Tel Aviv University, the Technion, Ben-Gurion University of the Negev, the University of



Inside the de Botton Institute for Protein Profiling

Haifa, and other institutions. Additional work paired Grand Center scientists with medical professionals at Sheba, Ichilov, Hadassah, Rabin and Barzilai Medical Centers.

Pillars of progress

Many projects begin at the Crown Institute for Genomics, which facilitates the discovery of genomic indicators of disease risk. Activities at the de Botton Institute for Protein Profiling have doubled over the past year, in part a reflection of the acquisition of a key instrument that enables faster and more sophisticated analysis than is possible using the Institute's previously available proteomic platforms. At the Mantoux Institute for Bioinformatics, experts use sophisticated algorithms and other techniques to sift through and make sense of reams of biological and medical data.

At the Maurice and Vivienne Wohl Institute for Drug Discovery, experts screen hundreds of thousands of chemical compounds as potential therapies using high-throughput systems. And this work just became more efficient, thanks to a new robotic system that has doubled the speed at which compounds can be delivered into well plates for screening and follow-up analysis. In addition, a new vial-handling robot will soon be installed to streamline the use of compounds synthesized in medicinal chemistry experiments. Also at the Wohl Institute, a new screening system—based on wide-field and confocal microscopy—is improving the Grand Center's ability to analyze everything from cells to complex, multi-layered specimens.

Advancing personalized medicine

The need for cooperation between institutions in Israel is as necessary today as it was when the Center opened its doors five years ago, says Dr. Berta Strulovici, the Grand Center's founding director. "An estimated 90 percent of top-selling, so-called 'blockbuster' medicines only work for 30 to 50 percent of patients, and adverse reactions caused by this 'imprecise medicine' account for about a third of acute hospital admissions every year," she says. "There is a clear need for more personalized approaches, and that's what our collaborative work at the G-INCPM is meant to accomplish."

Dr. Berta Strulovici

"An estimated 90 percent of top-selling, blockbuster medicines only work for 30 to 50 percent of patients, and adverse reactions caused by this 'imprecise medicine' account for about a third of acute hospital admissions every year," says Dr. Berta Strulovici.

Dr. Strulovici is retiring from her position as Director at the end of this year and a search for a replacement is underway.

The Center's founding Steering Committee chair, Prof. Aaron Ciechanover—a biologist and Nobel Laureate from the Technion—also stepped down recently, passing the baton to another outstanding Israeli scientist, Prof. Chaim Cedar of the Hebrew University. Prof. Cedar is best known for his pioneering work that revealed the existence of DNA methylation, a fundamental mechanism that regulates which genes are turned on, and turned off, in every tissue of the body. His studies, conducted with Prof. Aharon Razin, have had a major impact in the fields of developmental biology, control of gene expression, epigenetics and cancer research.

"The G-INCPM is unique in the way it streamlines cooperation between the many different types of scientists working to clarify the molecular basis of health and disease," Prof. Cedar says. "As a national resource, it empowers Israeli researchers, helping them generate comprehensive genomic data, which can be integrated into next-generation drug design and personalized therapeutics."

Defeating cancer recurrence

In one recent project, scientists at the G-INCPM's de Botton Institute for Protein Profiling teamed up with clinical experts from the

Department of Neurosurgery at Jerusalem's Shaare Zedek Medical Center to identify proteins involved in the recurrence of a cancer of the central nervous system known as malignant meningioma.

A meningioma is a tumor that forms on membranes that cover the brain and spinal cord, just inside the skull. Many meningiomas produce no symptoms and require no treatment. Malignant meningiomas, on the other hand, are treated either with radiation or surgery. However, up to 20 percent of such meningiomas recur—with three percent re-emerging in a malignant form. In some patients, tumors reappear a few months after the completion of treatment; in others, recurrence is delayed for five years or more.

The Shaare Zedek and G-INCPM teams successfully identified protein biomarkers associated with those patients likely to suffer swift recurrence of malignant meningioma, as well as late recurrence. In the future, these findings could help clinicians sharpen their diagnosis and strategize treatment, by identifying the quick-relapse patients who would most benefit from immediate radiotherapy, as well as others likely to have slower recurrence, and for whom radiotherapy's side effects might outweigh its benefits.

Treating Louis-Bar syndrome

Another recent project, spearheaded by Tel Aviv University scientists and experts at the G-INCPM's Wohl Institute for Drug Discovery, set out to identify compounds capable of correcting a defect in the mutant form of a gene called ATM—a defect associated with a serious autoimmune disease called Ataxia-telangiectasia, or A-T.

Also known as Louis-Bar syndrome, A-T is a rare, neurodegenerative syndrome that causes severe disability. Its symptoms, which can appear in early childhood, include impaired coordination and cognitive development, a

Investing in Israel's future

The Nancy and Stephen Grand Israel National Center for Personalized Medicine was never an abstract commitment for the philanthropists behind the name. That's because the Grands, who live in San Francisco, personally experienced how cutting-edge biomedical science can save lives—specifically, Stephen's own life.

Nancy and Stephen Grand

"Many years ago, I was diagnosed with a fatal blood cancer called multiple myeloma, and was given two years to live," he says. "At the same time, a new drug for this condition had just been approved. After a few months of taking the drug, I was in complete remission, and have remained so ever since."

The drug, Velcade, was based on the Nobel Prize-winning work of Technion scientists Prof. Avram Hershko and Prof. Aaron Ciechanover (who became the founding Chairman of the Grand Center steering committee).

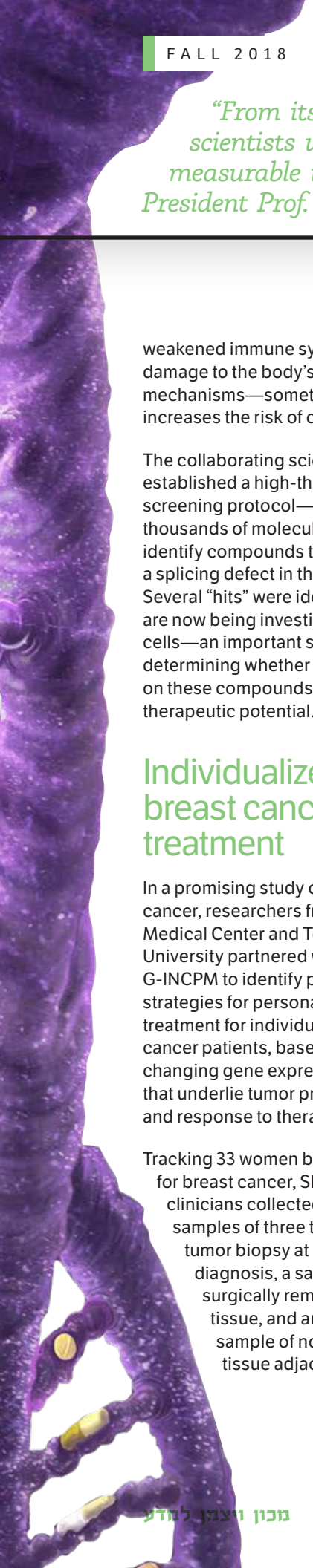
"When the Weizmann Institute approached us about supporting personalized medicine, the plan was always to build a national center—something that could bring together scientific and clinical research talent from all over the country, and, with the help of experts from industry, create targeted treatments that would benefit patients in Israel and beyond," Stephen says. "It's a new way to do biomedical science, and we are certain that over the long run, there will be great outcomes."

"Genome science is creating a wide-open world of open possibilities, because it allows you to look at the building blocks of life, identify the source of medical problems, and also find solutions. But to succeed, you need the best equipment, and the right people. That's why Nancy and I were excited about putting this platform in place."

The Grands' philanthropy encompasses academic pursuits, Jewish causes, and social welfare. At the Weizmann Institute, they also established the Grand Center for Sensors and Security. In San Francisco, they established the Nancy & Stephen Grand Family House, which provides temporary lodging to low-income families of pediatric cancer patients, enabling them to remain near their children while they are undergoing treatment. The couple also founded the Jewish Cultural Center in Odessa, Ukraine—the same city from which Stephen's father fled, thereby escaping the fate of so many victims of the Holocaust.

"My parents' generation was very close to Israel, and my father—who was president of a local chapter of the American Technion Society—passed that down to me," Stephen says. "That's why it's so meaningful for us to be involved in the Israel National Center for Personalized Medicine. We don't call our support a gift; we call it an investment in Israel's future."

"From its inception, the G-INCPM was envisioned as a place where scientists would come together and challenge themselves to achieve a measurable impact on biomedical progress," says Weizmann Institute President Prof. Daniel Zajfman.



weakened immune system, and damage to the body's DNA repair mechanisms—something that increases the risk of cancer.

The collaborating scientists established a high-throughput screening protocol—testing thousands of molecules—to identify compounds that correct a splicing defect in the ATM gene. Several "hits" were identified, and are now being investigated in cells—an important step toward determining whether drugs based on these compounds have true therapeutic potential.

Individualized breast cancer treatment

In a promising study on breast cancer, researchers from Sheba Medical Center and Tel Aviv University partnered with the G-INCPM to identify possible strategies for personalized treatment for individual breast cancer patients, based on the changing gene expression patterns that underlie tumor progression and response to therapy.

Tracking 33 women being treated for breast cancer, Sheba clinicians collected tissue samples of three types: a tumor biopsy at the time of diagnosis, a sample of the surgically removed tumor tissue, and an additional sample of non-cancerous tissue adjacent to the tumor site. These samples will undergo a full proteomic analysis at Tel Aviv University, after which experts from the Grand Center's Mantoux Institute for Bioinformatics will integrate the data, in order to link gene expression patterns with specific clinical outcomes.

This project is expected to aid in the development of diagnostic tools, as well as in the identification of genetic profiles associated with resistance to particular types of anticancer therapy.

Accurately predicting AML

Acute myeloid leukemia (AML) is characterized by an accumulation of mutations in hematopoietic (blood forming) stem cells. However, using this insight to predict AML onset is complicated by the fact that, as they age, healthy individuals also accumulate hematopoietic stem cell mutations.

Now, in a project performed in collaboration with the Grand Center's Crown Genomics Institute and Assuta Medical Center, Dr. Liran Shlush of the Weizmann Institute's Department of Immunology has developed a way to differentiate between individuals at high risk of developing AML and those with benign mutational activity.

Studying the blood cells of 95 individuals who later developed AML, Dr. Shlush and his G-INCPM colleagues performed deep sequencing of genes that repeatedly appeared in a mutated form. The overall mutational profile of these patients was shown to be distinct from control samples taken from healthy patients.

The genetic parameters revealed by Dr. Shlush's study were used to create a model that accurately predicted AML-free survival. This model, which can identify pre-AML risk many years prior to disease onset, could in the future potentially be used in the clinic for earlier detection, disease monitoring, and therapeutic intervention.

Activities taking place at the Grand Center are fulfilling the mission articulated at its founding: to quicken the pace at which scientific discoveries can be transferred from bench to bedside.

"From its inception, the G-INCPM was envisioned as a place where scientists would come together and challenge themselves to achieve a measurable impact on biomedical progress," says Weizmann Institute President Prof. Daniel Zajfman. "In five years of growth and highly productive interdisciplinary collaboration, this vision has become a day-to-day reality and we are moving toward better, more personalized patient care."

Ilana and Pascal Mantoux Institute for Bioinformatics

As tools evolve to allow biologists to gather ever-larger quantities of data, scientific experiments can only be fully analyzed through a platform that integrates computers, software tools, and databases. This is the essence of bioinformatics, and this is the mission of the Ilana and Pascal Mantoux Institute for Bioinformatics at the G-INCPM.

At the Mantoux Institute, experts in data science, mathematics, physics, biology, and software engineering help investigators answer their research questions. Working with Weizmann researchers, as well as physicians and scientists from other institutions, the Mantoux Institute provides bioinformatics support for proteomics, high-throughput screening, and genomic analysis.

The Mantoux Institute for Bioinformatics was established through the generosity of Pascal and Ilana Mantoux (pictured above).

de Botton Institute for Protein Profiling

Protein profiling involves the identification of the full complement of proteins expressed in a particular tissue, under a specified set of conditions and at a particular time, making it the very foundation of personalized medicine. At the G-INCPM, these important scientific activities have a single address: the de Botton Institute for Protein Profiling.

At the de Botton Institute, mass spectrometry and other advanced technologies are used to provide comprehensive analysis of proteins in biological samples. Working closely with scientific teams from the Weizmann Institute and beyond, experts at the de Botton Institute can identify and quantify even low-abundance proteins in any type of mixture, and detect modifications that take place after the protein is "minted" based on DNA instructions.

The Protein Profiling Institute was established through the generosity of Miel de Botton (pictured above). A clinical psychologist, art collector and singer-songwriter, Ms. de Botton studied law at Oxford University and psychology in Paris, where she worked as a clinical therapist and drug addiction counselor.

The Wolfson Family Charitable Trust of the UK gave a magnanimous gift for the renovation and construction of the Grand Israel National Center for Personalized Medicine, formerly the Solar Tower.

Maurice and Vivienne Wohl Institute for Drug Discovery

If searching for a needle in a haystack is considered difficult, consider the difficulty of searching for one medically useful molecule. This is the mission of the Maurice and Vivienne Wohl Institute for Drug Discovery at the G-INCPM.

Specializing in the design and execution of high throughput experiments, the Wohl Institute team designs and executes screening procedures for identifying molecules that, with further development, may provide the basis for new and useful medications. The Wohl Institute's capabilities rest on three pillars: a "library" of chemical compounds against which new molecules can be tested; the design of customized and automated testing procedures; and sophisticated software to analyze experimental data. Thanks to the outstanding technical infrastructure for molecular screening that is available at the G-INCPM, Weizmann investigators, as well as academics from other research institutions and pharmaceutical companies, rely on the Wohl Institute to move drug discovery forward.

The late Vivienne and Maurice Wohl (pictured above), benefactors of the Wohl Institute, are remembered for their rich legacy of support for medical science, welfare, and education.

Crown Institute for Genomics

Modern genomic approaches are helping to solve some of medicine's biggest puzzles, as tools that grew out of the Human Genome Project help reveal molecular "mugshots" associated with cancer, diabetes, infectious diseases, mental illness and other conditions. Genomic research informs and improves medical practice, by helping clinicians do a better job of matching individual patients with the therapies they need. This, in a nutshell, is the mission of the G-INCPM's Crown Institute for Genomics.

The Crown Institute's modular services include consultation and project design, sample preparation by type, sequencing services, and bioinformatics-based data analysis. Through collaboration with academics, members of the clinical community, and industrial experts, the Crown Institute promotes personalized medicine by helping research groups get answers to their scientific questions.

The Crown Institute was established through a gift from Lester Crown (pictured above) and his wife Renée.

Standing L-R: Danna, Naomi, and Sharon Azrieli. Seated: Stephanie Azrieli.

The Azrieli family

Transforming two homelands through philanthropy, education

Spotlight On

The soaring structures that bear the Azrieli name—the iconic Azrieli Towers in Tel Aviv—have contributed to the rapid transformation of the Israeli urban landscape in recent decades. Over the years, the Azrieli Foundation has leveraged philanthropy to transform other Israeli landscapes: scientific, educational, and social.

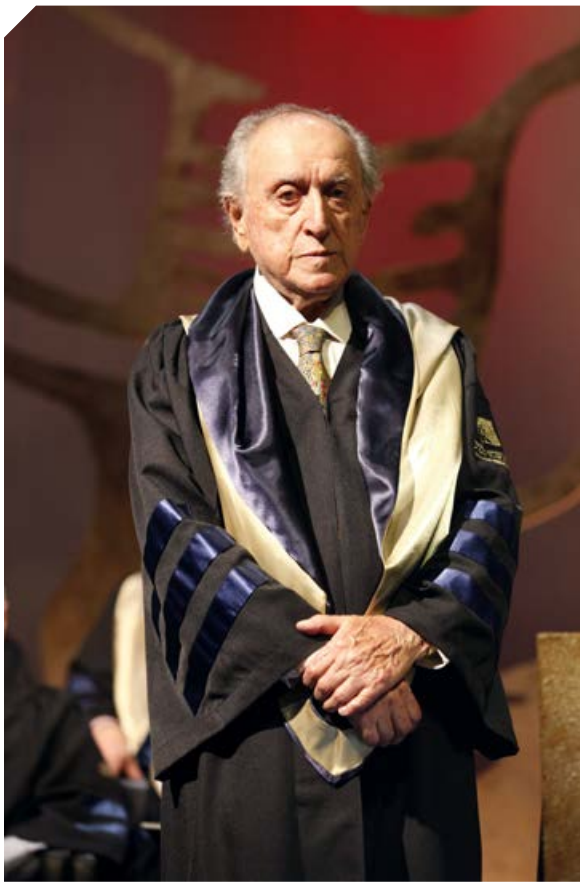
During his lifetime, the Israeli-Canadian architect and real estate executive David Azrieli helped build Israel from the ground up, and made a major impact in Canada as well. But, says his daughter Naomi, who is chair of the Azrieli Foundation Canada and co-chair with her sister Danna of the Azrieli Foundation Israel, "He was just as concerned with the legacy and the impact he could make with his philanthropy."

Today, nearly three decades after the foundation's establishment and four years after David Azrieli's passing at age 92, the foundation's charitable influence throughout Israel—and at the Weizmann Institute of Science in particular—is about as indisputably present as the Azrieli malls and buildings that have become household names.

At the Weizmann Institute, the Azrieli Foundation has made a deep impact on students and on the life sciences. A 2016 gift enabled the establishment of the Azrieli National Institute for Human Brain Imaging and Research, a joint philanthropic-government investment; it began operating in April of this year. The foundation also generously donated to advance Fragile X research, established the Azrieli Institute for Systems Biology, funded new scientists' lab start-up needs, and continues to sponsor the most outstanding students through its nationwide Azrieli Fellows Program. David Azrieli received a PhD *honoris causa* from the Institute in 2013, and the Azrieli Foundation is a member of the President's Circle.

"The Azrieli family's impact is incredible—for the Weizmann Institute and for the State of Israel," says Weizmann Institute President Prof. Daniel Zajfman. "We share the understanding that excellent people are the foundation for excellent science, and that taking science to the next level means integrating various disciplines and putting the best scientists in the driver's seat."

Focused on neuroscience research, the Azrieli National Institute for Human Brain Imaging and Research houses a 7-Tesla MRI scanner—the only magnet of its size in the Middle East and only the second of its type in the world usable for studies on humans. Directed by Prof. Noam Sobel, head of the Department of Neurobiology, the new Azrieli National Institute will serve scientists and physicians across Israel engaging in studies of the human brain.



David Azrieli z"l

"The first thing Weizmann has is its people—they are its biggest resource. I love the curiosity-driven philosophy of Weizmann," says Naomi Azrieli. "The possibilities offered by the 7-Tesla MRI could be clearly seen by the Weizmann

researchers and that was compelling to us. Moreover, it is a partnership between major Israeli institutions, and we wanted to enable Israeli researchers to work together and help them explore new frontiers."

Indeed, it is that drive—to discover new frontiers—that was a defining characteristic of David Azrieli during his lifetime, and carries through as a defining characteristic of the foundation.

The first frontier

Born in 1922 in Poland, David Azrieli grew up in a home imbued with Zionism. His story of escape at the start of World War II, *One Step Ahead*, was written by his daughter Danna and published by Yad Vashem in 1999. The title reflects his experiences in evading capture during the Nazi invasion of the Soviet Union, hiding and working on farms and eventually joining the Anders Army, the anti-Nazi Polish armed force that enlisted Poles then located in the Soviet Union, including some Jews. When Azrieli found himself in Tashkent, the Asian architecture made an impression on him, says Naomi.

After the war, he learned that his parents, his youngest brother, and his sister had all perished. His older brother survived, landing in Palestine five years later.

"When my father arrived in Israel, it was the beginning of a whole new life—a dream, but so much uncertainty," says Naomi.

Azrieli enrolled in the Technion, where he studied architecture. He then fought in the War of Independence. In 1954, after traveling the world, he serendipitously landed in Canada, where he met his wife Stephanie. They had four children: Rafael, Sharon, Naomi, and Danna. He put up his first building in Montreal and went on to establish Canpro Investments, which builds and owns office buildings and shopping centers throughout Canada and the United States. In Israel, he launched the Azrieli Group, which owns shopping malls, several office buildings in Israel and abroad, and senior housing properties; it also holds stakes in companies engaged in the energy field, and in chemical, water and wastewater treatment.

"He loved Canada and he loved Israel," says Naomi. "Canada gave him his first opportunities in business and he was then able to bring back what he had learned to build in Israel. He was successful and involved in the communities in both countries and always said he had two homelands."

It starts with education

Early on, David and Stephanie were engaged in ensuring their good fortune was used to improve the lives of others, even when they had little to give. "My parents' social life revolved around Zionism and the Jewish community and there was a real focus on philanthropically supporting educational institutions in Israel. That was an integral part of our environment when we were growing up," recalls Naomi.

The family's starting point in giving was education. David hadn't been a particularly good student, until a middle school teacher inspired him by introducing him to literature, and stories of innovation and creativity. He was changed, and quickly began to excel in his studies. "As a result of this experience, my father believed that one teacher, or person, can make all the difference in a child's life," says Naomi. One of the foundation's first—and ongoing—programs deals with ensuring that kids stay in school.

While the Azrieli Foundation began its charitable work in 1989, it was in the early 2000s, after David turned 80, that it turned into a major philanthropic force in Canada and Israel. He began donating large sums during his lifetime and then left all of his wealth to the foundation when he died. All three of his daughters, including Sharon,

"We have a real, personal passion for everything we do at the foundation, and in the enabling and catalyzing force of education. And from there we have developed and broadened what we do and hopefully we will become more effective in making change as philanthropists," says Naomi Azrieli. 22–23

a successful opera singer, sit on the foundation's board.

"We have a real, personal passion for everything we do at the foundation, and in the enabling and catalyzing force of education. And from there we have developed and broadened what we do and hopefully we will become more effective in making change as philanthropists," says Naomi. "We want to touch people's lives and change things for the better."

David's belief in Israel's educational institutions started with his time at the Technion; his involvement there and with other institutions turned him on to the incredible advances in science made by Israeli researchers of which he was so proud. "My father was an exceptionally creative person and a force of nature with tremendous energy," says Naomi.

Naomi Azrieli

"He was also very taken by science. He and my mother read a lot about science and were always interested in how science would change the future."

The Azrieli Foundation also supports the publication of Holocaust survivor memoirs and Holocaust education, a school empowerment program, programs for adults with disabilities, and music initiatives, in both Israel and Canada.

Through the Azrieli Fellows Program, the foundation became familiar with the Weizmann Institute, which is a major beneficiary. The program supports outstanding students at universities throughout Israel who engage in volunteer work and show promise as exceptional communicators and leaders. These students come from a wide range of disciplines, and benefit from a fruitful environment for networking and exchange. The program now includes Canadian postdocs and will soon expand to include funding for international postdocs, in part with the goal to create ambassadors for Israel.

In establishing the Azrieli Institute for Systems Biology in 2012, headed by Prof. Naama Barkai, the foundation was inspired by the fact that this new field was made possible by advances in math, computer science, and physics that led to a new way of exploring biology. The Azrieli Institute has since funded hundreds of projects,

Danna Azrieli and Prof. Daniel Zajfman dedicating the family's gift to Fragile X research.

and attained renown as a pioneer in the field.

A gift last year to advance Prof. Irit Sagi's research on Fragile X syndrome was the actualization of a seed of hope planted years ago. Rafael Azrieli has Fragile X, as do two other relatives, and David voiced a wish to fund promising research on this disorder. It is the number-one cause of cognitive delay, and many individuals with Fragile X also have autism. "One gift really led to the other," says Naomi. "It was the systems approach that got us thinking about the brain in a different way. I believe that the brain is going to be the last and perhaps most important frontier of science, and so we want to support and advance this research in any way we can."

CELEBRATING THE GLOBAL WEIZMANN FAMILY

The Global Gathering of the Weizmann Institute of Science, which took place in Boston in early June, brought together 350 Institute friends and supporters for three days of science—with plenty of art, music, and camaraderie.

Opening night at the John F. Kennedy Presidential Library and Museum honored the new inductees to the prestigious President's Circle, which was followed by two days of learning and celebrating Weizmann science. Sessions were held at MIT—where MIT President Prof. Rafael Reif welcomed guests—and at Harvard University, where then-President-designate Prof. Lawrence Bacow did the same. An evening out at the Boston Pops Orchestra was a highlight, and the closing gala at the Museum of Fine Arts celebrated the 75th anniversary of the Weizmann American Committee—and the close of an extraordinary few days.

At the closing gala, Weizmann Institute President Prof. Daniel Zajfman congratulated the American Committee, saying it is "a central pillar in the global fundraising efforts of the Weizmann Institute, generating tens of millions of dollars in support of science for the Institute every year. Its work on behalf of the Weizmann Institute cannot be overstated."

Institute Board Chair Prof. Jehuda Reinharz spoke eloquently about the value of philanthropy in advancing Israeli science, and how the Institute is the realization of Dr. Chaim Weizmann's dream that science would serve as the backbone of Israel's economy and society.

He thanked the Global Gathering co-chairs, the father-son duo of Ted and David Teplow of Boston, all of the events' generous sponsors, the honorary committee chairs from around the world, and finally the Patron Sponsors and Leadership Sponsors.

Special Section

24–25

President's Circle

At the opening night of the Global Gathering, 19 new families and individuals were inducted into the President's Circle, bringing the total number of members to more than 230. The induction ceremony takes place every two years at the Global Gathering.

מכון ויצמן למדע

Q&A

A day at MIT with Prof. Rafael Reif

A full-day symposium at MIT showcased the research of Weizmann scientists Prof. Shimon Ullman of the Department of Computer Science and Applied Mathematics, and of Profs. Michal Schwartz and Rony Paz of the Department of Neurobiology. Weizmann Institute President Prof. Daniel Zajfman presented the Institute's vision and priorities. The day was kicked off with a warm welcome from MIT President Prof. Rafael Reif.

Prof. Reif is the 17th President of the Massachusetts Institute of Technology. He previously served as MIT's provost, from 2005 to 2012. He received a degree in electrical engineering from the Universidad de Carabobo in Venezuela, and earned his doctorate in the same field from Stanford University.

L-R: MIT President Prof. Rafael Reif, Weizmann President Prof. Daniel Zajfman, Tova and Sami Sagol.

Celebrating the Sagols

Tova and Sami Sagol were honored for their visionary gift to support a series of multidisciplinary collaborations between pairs, or teams, of faculty from the Weizmann Institute of Science and the Massachusetts Institute of Technology across all areas of science.

Mr. Sagol hopes others will follow his lead, he says "so that Israel develops a deeper connection with Massachusetts and—when we're done with that, the sky's the limit."

Q What has been the value for MIT in its relationship with the Weizmann Institute over the years, and what are your hopes and expectations moving into the future?

A MIT's relationship with Weizmann has been remarkably productive. More than 40 years ago, MIT professors Ron Rivest and Leonard Adleman partnered with Weizmann's Adi Shamir to develop the RSA cryptosystem, the first public-key cryptosystem. In the 1980s, Shafi Goldwasser—who holds appointments at both of our institutions—joined Weizmann's Oded Goldreich and MIT's Silvio Micali to develop the gold standard for enabling secure Internet transactions. Their research is widely recognized as revolutionizing the science of cryptography, and it earned Professors Goldwasser and Micali the Turing Award, the Nobel Prize of computing. And MIT's Center for Brains, Minds and Machines partners with the Weizmann Institute.

The agreement we just signed [Sagol gift, see box] marks the start of an exciting new era of collaboration that I believe will benefit both institutions' students and faculty, and society at large.

Q Why are international collaborations important in science?

A When leading scientific and technical institutions partner with colleagues and supporters around the world, it allows each group to use its distinctive strengths to help make an impact on big, urgent global challenges—challenges that no individual, institution, or country can address on its own.

Q What is one field of research that you see taking off in a big way and changing society in the coming years?

A Although it sometimes feels like artificial intelligence is everywhere we look, its foundations are, in fact, relatively old. If we want to achieve the kind of breakthroughs that will revolutionize the field of AI, it's going to take new science. Just imagine if the next giant leap in artificial intelligence comes

Q&A

L-R: Prof. Rafael Reif, Prof. Daniel Zajfman

from the root of intelligence itself: the human brain. That's how big we need to think to generate new knowledge in this area, as well as enable its practical impact.

Q Why is philanthropy important for advancing science?

A Venture capital funding works wonderfully for concepts and companies with the potential to reach market profitability quickly. But very understandably, investors want a quick return on their investment. They don't want to wait a decade or more to be rewarded.

Philanthropists are looking for a return on their investment too, of course, but a different kind of return, and on a different timeline. Research in "tough tech" fields—energy, human health, climate and clean water, for example—requires patience. Philanthropy gives our researchers many things they need—staff, space, equipment—but I think the greatest thing it provides is time. Time to explore. To test. To take risks. And to see where a line of inquiry leads without thinking about financial returns.

Q What role should MIT—and scientific research institutions more broadly—play in advancing science literacy among the public and at the government level? Is there an urgency today to advance the public understanding of science, and if so why?

A Let me answer your second question first, and with an emphatic "Yes"! At a time when enthusiasm for innovation remains high, and rightly so, I worry that support for scientific discovery is waning. Basic research is slow, painstaking, and rigorous. But it is critical for a healthy, productive, and prosperous society. We must do more to communicate its importance. Given our rich tradition of engagement with our respective federal governments, I do believe that institutions like MIT and Weizmann have a special role to play in advancing scientific literacy. I spend a great deal of time in Washington, D.C., talking with lawmakers and federal officials. I firmly believe that science and technology can provide answers to some of society's most challenging problems, as well as provide the foundations for the future.

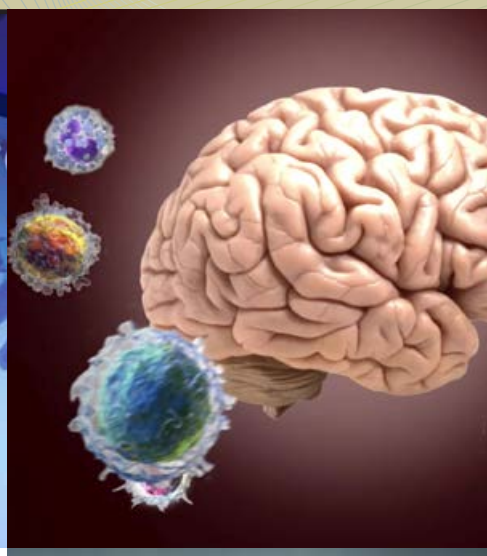
Q Israel and America are both countries of immigrants that rely on the strength of human brain power, and so education is a high priority in both places. As an immigrant to America, can you reflect on your own experience?

A This is an issue that means a great deal to me, both personally and professionally. My parents fled Eastern Europe for South America in the late 1930s to escape the Holocaust. They stressed to my brothers and me the value of hard work and education. My third brother, Isaac, was the first in our family to go to high school and then college, and his example showed me that I might be able to do the same.

During my time at MIT—close to four decades—I have witnessed the magnetic strength of the U.S., attracting some of the world's smartest and most talented young people. More than 40 percent of our graduate students and faculty were born outside of the U.S. That mix of backgrounds, experiences, and perspectives is critical. It helps us to educate our students to be global problem solvers, and it enriches our campus.

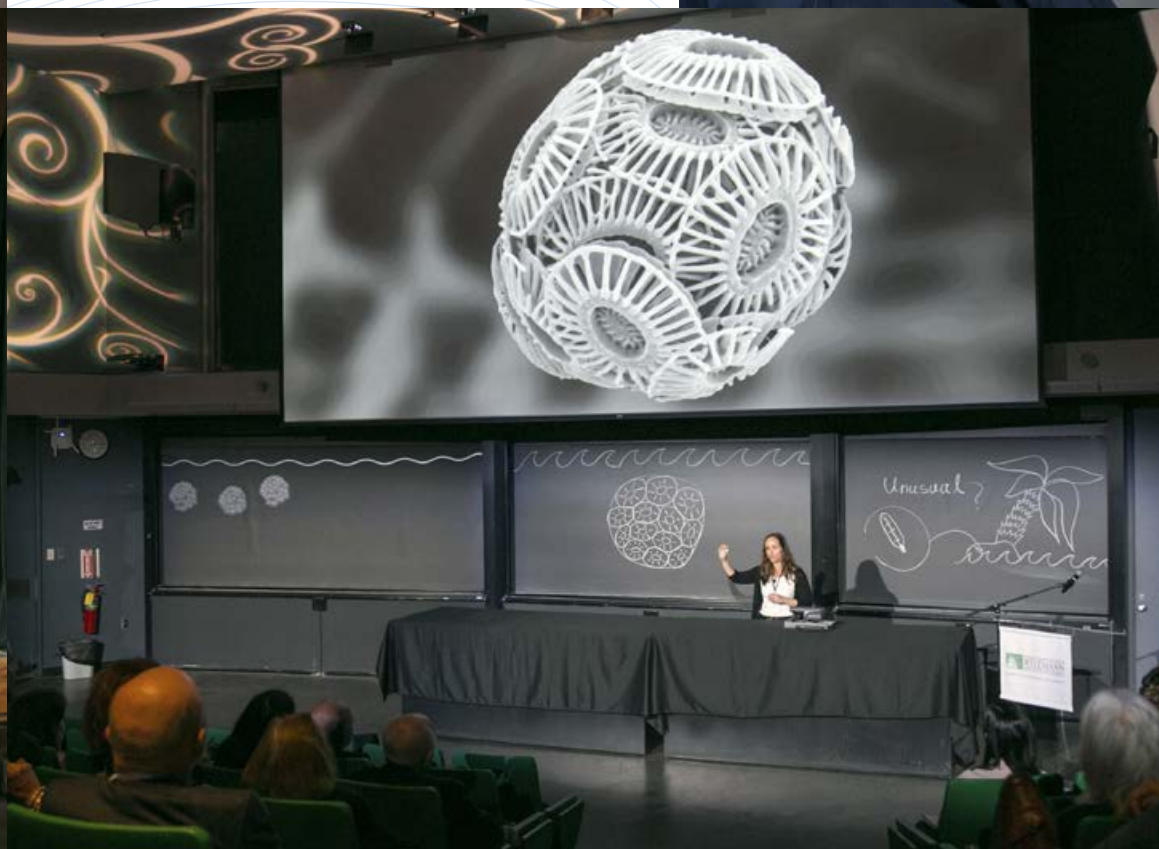
I am living proof of the power of education: No matter where you come from, educational opportunity—paired with hard work and dedication—can transform a young person's life. Now, with the great honor of leading MIT, I feel a deep responsibility to ensure that our campus—and our country—continues to attract and welcome some of the world's finest minds.

Scan the QR code for the full interview, or visit Weizmann Compass online.



Clockwise from top center: Prof. Shimon Ullman, Prof. Sarel Fleishman, Dr. Einat Segev, Prof. Michal Schwartz, Prof. Tzachi Pilpel, Prof. Rony Paz.

TED-style presentations by Weizmann scientists focused on a range of cutting-edge areas of discovery. For instance, Prof. Michal Schwartz of the Department of Neurobiology discussed her game-changing insights into Alzheimer's disease and its connection to the immune system.



David Teplow opened the lunch at MIT, introducing Prof. Skylar Tibbits of the MIT Self-Assembly Lab and tracing his own family's deep connection to the Weizmann Institute, starting with his great-uncle, Dewey Stone. Mr. Teplow and his father, Ted, were the co-chairs of the Global Gathering.

Hailing Weizmann at Harvard

Prof. Larry Bacow (pictured bottom left), who took the reins as Harvard University President on July 1, welcomed guests to a full-day symposium of Weizmann science held at the Havard Science Center. Speaking to the audience of friends, he said, "Science needs many more people who care deeply about it and help promote it, and you are doing just that—for Weizmann, for science, and for the world."

The "Friends of Larry Bacow" (pictured below, L-R: Peter Roth, Erin O'Boyle, Jack Dawley, Larry Bacow, Sarah Abrams, Allan Cole, David Geller, and Tom Ford) led by Mr. Geller of Brookline, Massachusetts, generously supported the day of science at Harvard, in a gesture to honor the new Harvard President.

Q&A

Directed evolution: A chat with Prof. George Church

Imagine having "editing rights" to the master plan of life. That's what science has accomplished with CRISPR, a molecular tool that can change, delete, and replace genes in living cells and organisms. One of the foremost authorities on this system is Prof. George Church of Harvard Medical School.

Prof. Church was the first to make the new bacteria-based DNA-editing tool CRISPR usable in humans, in collaboration with the lab of Prof. Feng Zhang at the Broad Institute. Its punchy acronym stands for Clustered Regularly Interspaced Short Palindromic Repeats, but its innovation is hardly anything to be taken lightly: It is capable of fundamentally altering the natural world. Like a molecular scalpel, CRISPR is able to change, delete, and replace genes in living cells and organisms.

Because it can enable gene drives—wherein a change made in one chromosome would copy itself in every successive generation, so that all descendants would inherit the change—it holds promise for eradicating diseases and making crops resistant to pests.

An initiator of the Human Genome Project, Prof. Church directs the Personal Genome Project, the only open-access information on the human genomic, environmental, and trait data. Co-author of the first direct genomic sequencing method, he contributed to dramatically lowering the cost of sequencing individual human genomes. He also leads the Synthetic Biology lab at Harvard's Wyss Institute for Biologically Inspired Engineering, where he oversees the directed evolution of molecules, polymers, and whole genomes.

We caught up with Prof. Church after his keynote address at the Global Gathering.

Q Are we entering an era in which humans determine the future of evolution?

A I would argue that we have already been influencing our own evolution with existing medical technology, but with CRISPR, we're able to begin going much faster. Just as there is potential for good, there is potential for bad. I don't think anyone would argue against "deleting" malaria from mosquitos, or fixing schizophrenia, Alzheimer's, or HIV. But when we change the nature of an entire species, we don't know what the effects will be on other species, and on the environment. So we also must ensure that we have the ability to restore an organism to its original genetic composition.

Q Do scientists working on CRISPR have a responsibility to explain what they're doing to policymakers and the public?

A Absolutely. As the potential for CRISPR as a tool in medicine becomes more real, there are many regulatory, political, and social hurdles to cross. Scientists have to make sure the policymakers know what they are doing and educate the public about what's ahead, so they can be involved in the discussion. Everybody has to be literate about the risks and benefits. Scientists like myself working in this area can often see decades ahead of us. Our job is not only to move the science along, but to consider the ramifications of the various scientific avenues and predict which ones will be most fruitful and which will be fraught with problems.

Q&A

Prof. George Church

Q Why do you have a bioethicist embedded in your lab?

A Prof. Jeantine Lunshof is an independent philosopher and bioethicist who has been associated with my lab since 2003. This collaborative relationship is unusual, and what she's doing is very important. As scientists, we are now able to create and manipulate life. We need to tread carefully, and move forward thoughtfully. She raises questions with us and helps us answer them. Should scientists enhance people's genetic inheritance—to produce "designer babies"? Where do we draw the line between therapy and enhancement? Should CRISPR editing extend to human eggs, sperm, and embryos? Prof. Lunshof and I have written about a dozen papers together, and there are many more questions ahead.

Q Should we feel excitement or dread about the future of gene editing?

A The biggest thing at risk is diversity. When discussing the use of CRISPR to improve the human species, the first thing people think about is looks. But is the prospect of making people better looking the worst scenario we can come up with? Ok, it would be weird for us all to be tall and blond and blue-eyed, but that's not a public health threat.

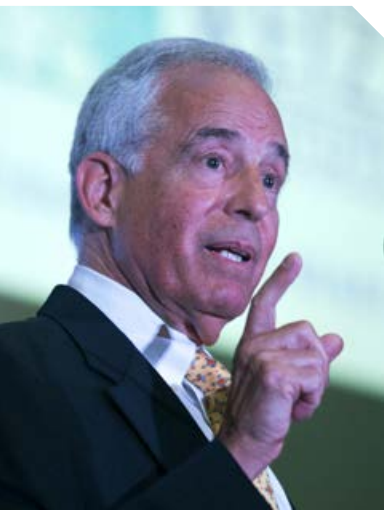
The implicit point in that worry is the loss of biological diversity: If we all had the same immune system and the same exact genetic makeup—now that would be a problem. The lesson of evolution is that diversity wins. We have to have ways to reverse mistakes, and make sure that this technology stays safe in the hands of well-intentioned scientists.

If we proceed smartly and responsibly, genome editing could revolutionize human health and reduce suffering, make us smarter, improve our memories, and extend our life spans. Also, from an economic point of view, it makes sense to sequence genomes and edit out the really bad stuff because our biggest health expenditures are on the sickest individuals, including children born with devastating illnesses. With CRISPR, children who were genetically destined to be very ill can be born healthy—because we edited out the disease in their father's sperm before they were even conceived.

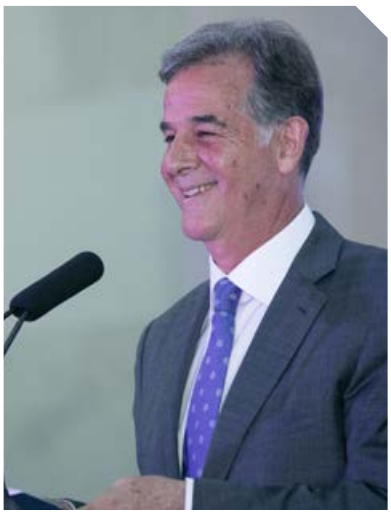
Harmony and high notes with the Boston Pops

Weizmann Institute scientists and the Boston Pops Orchestra, led by Keith Lockhart, created a special concert entitled "Sounds of Science" that emphasized musical and scientific harmony and collaboration.

A fine closing gala at the MFA

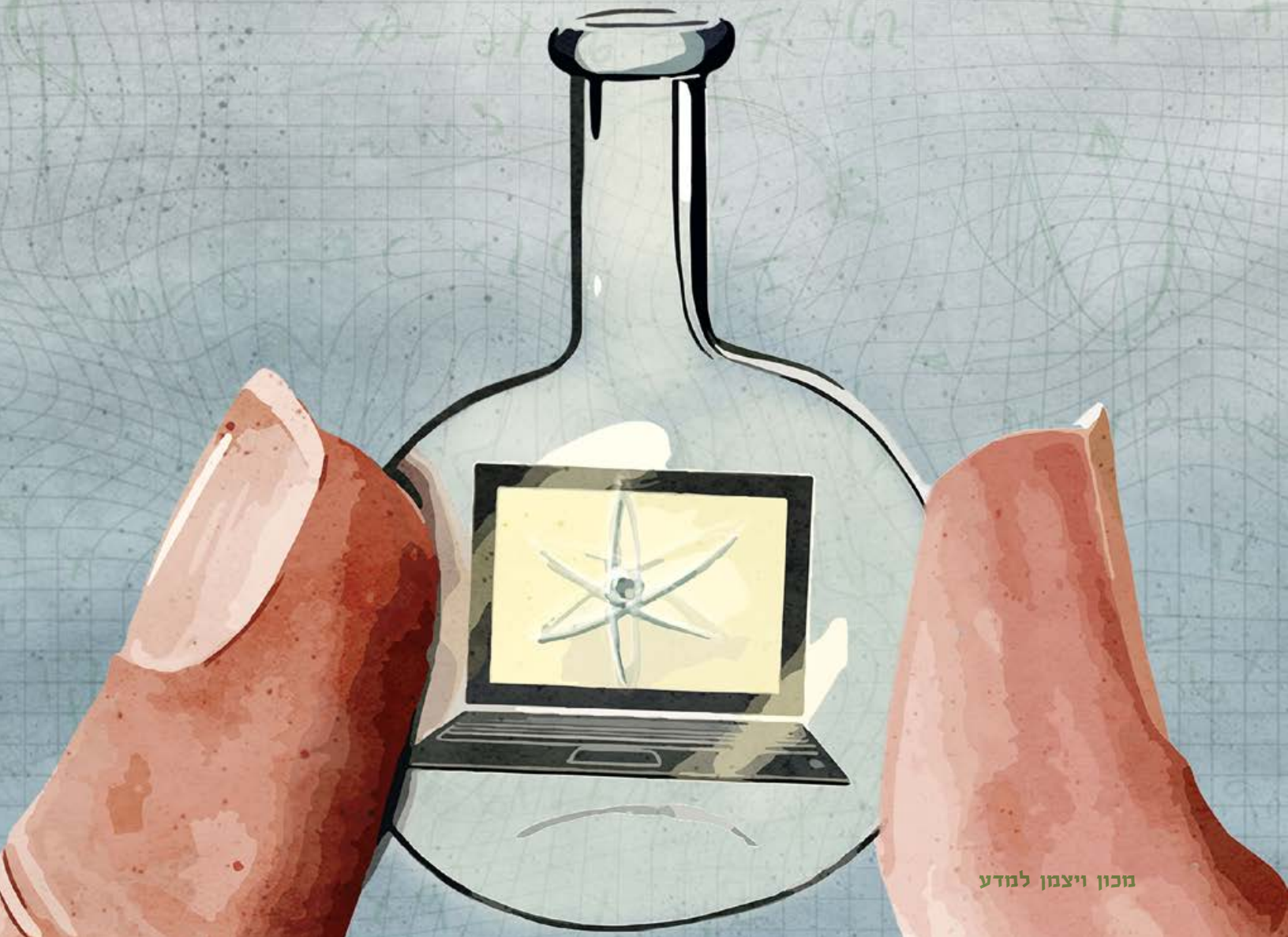


The closing gala of the Global Gathering, held at Boston's Museum of Fine Arts, highlighted the 75th anniversary of the American Committee. Prof. Jehuda Reinharz (left), Chairman of the Weizmann Institute International Board, outlined his vision for the Institute, while Marshall Levin (right), CEO of the American Committee, led ceremonies around the milestone year. Ellen Merlo, National Chair of the American Committee, congratulated guests on a successful Global Gathering.



THE SCIENCE OF SMALL

It's just a matter of time before quantum particles change our lives



מכון ויצמן למדע

Science Feature

34–35

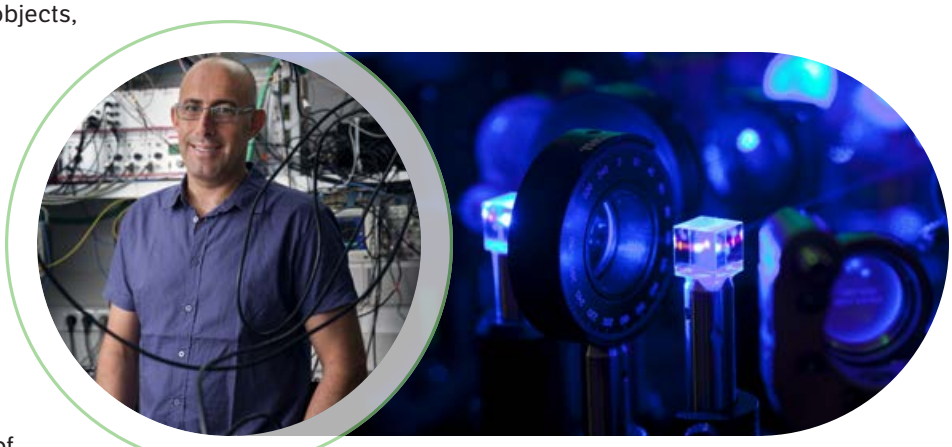
Today, the axiom that there is more to what we see than meets the eye isn't just a philosophical statement about ascertaining reality. For physicists working in the microscopic realm, this is the concept that will lead us into a new quantum revolution.

The devices and technology that we take for granted today—laptop computers, the Internet, mobile phones, GPS gadgets, superconductors, and lasers—are the products of a scientific sea change that began a century ago. In this so-called "first quantum revolution," physicists figured out the laws governing microscopic particles like atoms, electrons, and photons, and worked with engineers to translate their insights into real-world applications. But while these technologies have become ubiquitous in modern life, and most of us feel like we can barely catch up before the next one has arrived to confound us, this is just the beginning.

Microscopic objects don't comply with the laws of classical Newtonian physics—which describe the mechanical principles of visible objects, like clouds, coffee cups, and even cells. The mechanics of microscopic objects also contradict our everyday experience. Unlike macroscopic objects, which can exist in only a single physical location at any given time—they are where they are and can't be found anywhere else—the individual microscopic particles that compose our macroscopic, human-sized world can exist in multiple realities simultaneously, and we can only speak of where a particle is in terms of probability. This phenomenon is known as superposition. Today, physicists are hard at work characterizing this and other phenomena of the microscopic world, hoping to recognize their full potential—and that means there's a second quantum revolution in the making.

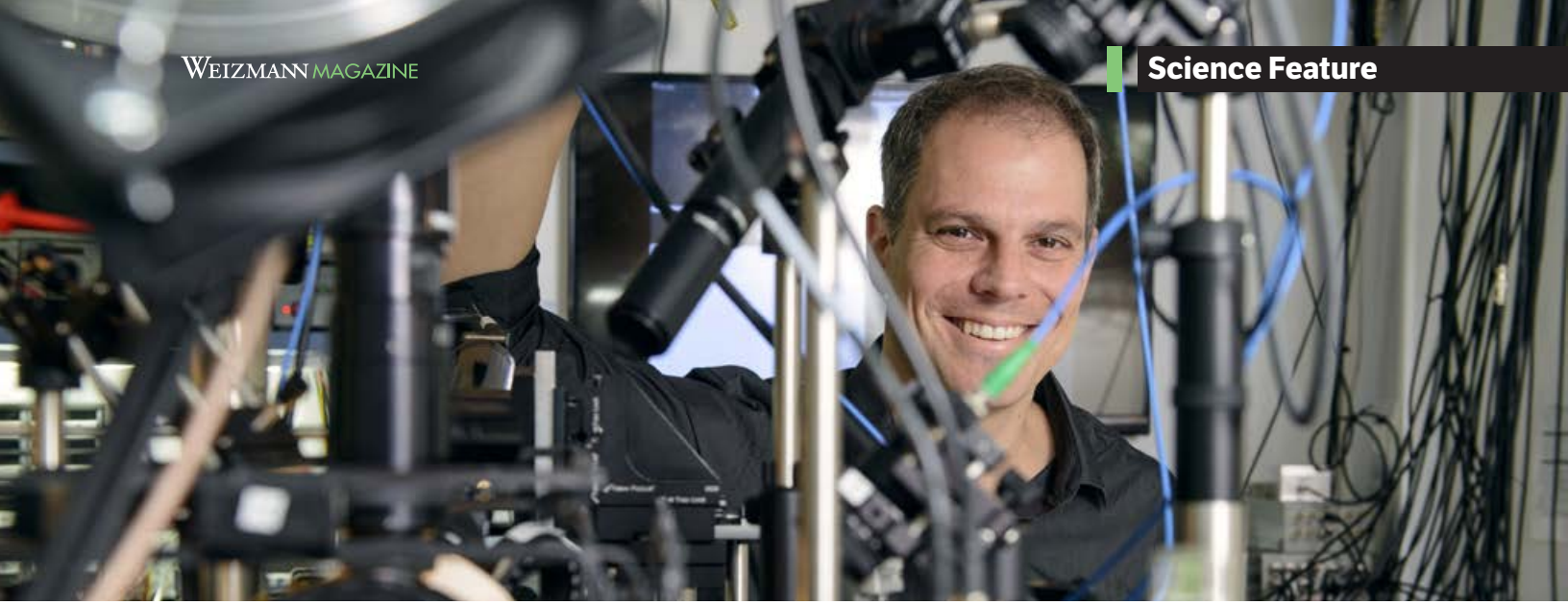
"Superposition is where science gets really weird," says Prof. Roee Ozeri of the Department of Physics of Complex Systems. "Some nanoparticles can be thought of as particles like waves, which can have different positions and energies at different points and move at different speeds—and even be in two different places at once."

Superposition offers a kind of flexibility of space and time to matter, which is why physicists view it as one of the two key phenomena that lie at the heart of quantum behavior. The other is the fact that quantum particles can be deeply connected without direct physical interaction. Quantum particles can't be characterized independently without their partners—like long-distance lovers who see the other as an extension of themselves. That principle is called entanglement.



Prof. Roee Ozeri

These two principles—superposition and entanglement—form the basis of the second quantum revolution. In this new era, quantum scientists are working to develop the means to observe, manipulate, and control the behavior of a single electron, photon, or other microscopic bit; moreover, they are working to control the quantum



Prof. Barak Dayan

behavior of systems composed of many atoms or electrons, engineered from the bottom up.

Scaling up

What are the implications of quantum science? The second revolution is expected to lead to technologies capable of doing everything our current technology can do—but much faster, and with staggeringly higher efficiency and power, solving and accomplishing tasks that aren't even fathomable today. Numerous fundamental aspects of existence that could not be sensed, recorded, computed, or analyzed using classical systems—features too intricate, complex, and massive, or alternatively, too sensitive and delicate to be observed—may now be amenable to second-revolution quantum science. The hoped-for result will be better, faster everything: encryption and transfer of information, sensors, computers, and a myriad of devices.

Quantum computers are expected to outperform classical computers on computational tasks thanks to their ability to calculate an exponentially large number of computations simultaneously. Quantum information technology is set to ensure tighter privacy and security through astonishing degrees of encryption. Quantum simulators will be a boon to science as they will allow scientists to simulate materials or chemical compounds, facilitating the development of new intelligent materials, from solar cells to nano-pharmaceuticals. Meanwhile, quantum sensors will be a leap forward for space and geographical studies, via ultra-sensitive and precise measurements of subatomic particles. Quantum science will shed light—quite literally—on gravitational fields, magnetic fields, and fundamental physical constants on the minutest of scales.

Among commercial entities and in the halls of academia, the race is afoot to create the first quantum devices.

At the Weizmann Institute, physicists and computer scientists are leading the way. They already have a history of firsts, starting with WEIZAC, the first computer in the Middle East and one of the first in the world; also, the RSA encryption algorithm developed in the 1970s by Prof. Adi Shamir and two MIT colleagues that became the basis for secure computer transactions. Today, the Institute is home to leading experts in both experimental and theoretical physics who conduct cutting-edge research on quantum systems. The two areas of physics that are laying the foundation for the quantum era are atomic, molecular, and optical systems (AMO), and condensed matter systems (CM).

The promise of photons

Many of the hi-tech devices we use today operate thanks to billions upon billions of photons—the smallest indivisible quantum (a piece, or bit) of light. Why do photons matter? It turns out that photons are the best candidates for long-distance quantum-information transfer: they are extremely light, capable of super-fast travel, barely interact with the environment, and can be directed via optical fibers. Somewhat surprisingly, the most powerful effects occur when utilizing a single photon.

For some time, it has been possible to create photons in isolation, but they don't perform all that well yet. Scientists are still trying to figure out how to effectively create many single photons. Prof. Barak Dayan of the Department of Chemical and Biological Physics is among the Institute's AMO

"Superposition is where science gets really weird," says Prof. Roee Ozeri. "Some nanoparticles can be thought of as particles like waves, which can have different positions and energies at different points and move at different speeds—and even be in two different places at once." 36–37

scientists tackling this challenge. He and newly hired scientist Dr. Serge Rosenblum worked together to successfully remove a single photon from a pulse of light.

At the same time, photons' very lack of interaction has stymied scientists hoping to build an Internet around them. Prof. Dayan and Prof. Ofer Firstenberg of the Department of Physics of Complex Systems are trying to build devices and transistors based on photons. They have devised ways of forcing photons to interact at will and have found a transistor for light, by having atoms mediate the interaction between the photons. Such techniques have the potential to enable the execution of quantum algorithms using light, and could help merge quantum computers and the quantum Internet into the communication force of the future. In a recent study published in *Nature Physics*, Prof. Dayan described how he was able to create a "logic gate" in which a photon and an atom automatically exchange the information they carry, which has key implications for creating quantum computers.

The hidden world of electrons

For decades, Weizmann physicists have been experimenting with electrons, atoms, and all that they are capable of: their interaction, ability to split, and distinct behavior. Advances in this field, condensed matter physics, have led to an important focus on so-called electron interferometry—the study of the wave-like properties of electrons and how they interact with their environment. Prof. Moty Heiblum of the Department of Condensed Matter Physics and many of his colleagues have advanced the field to the point where quantum electrons can be controlled, manipulated, and exploited.

This field of research has led to the development of sophisticated semiconductors and modern nanotechnology. But there's much more ahead.

The relatively new field of topological states of matter holds promise for creating quantum computers. Topological materials and states involve a kind of order very different from conventional bulk materials, in that electrons on the surface of a material behave differently than those inside the material itself. The special nature of such topological materials and states can be leveraged for the creation of new materials. Dr. Binghai Yan of the Department of Condensed Matter Physics straddles the world of theory—figuring out how such states work—and experimentation: trying out the materials to synthesize new materials and devices such as quantum computers.

A native of China, Dr. Yan was recruited several years ago, drawn to the Weizmann Institute because of its rare expertise in the microscopic realm and in topological materials in particular. Dr. Yan is

Dr. Binghai Yan

collaborating with pioneers in the field, including Prof. Ady Stern of the Department of Condensed Matter Physics, who has elucidated how topological states work in electronic systems, which manifest electronic properties that are remarkably indifferent to changing environmental parameters and conditions—properties that may be of particular importance in the design of quantum computers.

American Committee returns to DC

The American Committee celebrated the return of its Washington D.C. and Mid-Atlantic Office with a special event at the Embassy of Israel. The evening attracted about 65 local Weizmann supporters. After opening remarks by CEO Marshall Levin, National Chair Ellen Merlo discussed the significance of reestablishing the organization's Mid-Atlantic Region. Reuven Azar, Deputy Head of Mission at the Embassy of Israel, welcomed guests and illustrated the power of scientific cooperation to build bridges between Israel and other nations.

L-R: American Committee CEO Marshall S. Levin, National Chair Ellen Merlo, Mid-Atlantic Regional Chair Pennie Abramson, and Gary Abramson.

Following an introduction by Mid-Atlantic Regional Chair Pennie Abramson, Prof. Avigdor Scherz of the Department of Plant and Environmental Sciences discussed his research (see page 6). Together with the late Prof. Yoram Salomon, Prof. Scherz invented a revolutionary, noninvasive approach to treat early-stage prostate cancer. To conclude the night, Jill Moskowitz, Mid-Atlantic Region Executive Director, spoke about strengthening and growing the Weizmann Institute's community of supporters in Washington, D.C. and beyond.

Wonderful Women of Canada

Weizmann Canada's fifth annual Wonderful Women event in support of the Israel National Postdoctoral Award Program for Advancing Women in Science took place on May 23 in Toronto and featured a special keynote address by actress and activist Mira Sorvino. More than 300 people were in attendance at the event, which featured Dr. Ruth Scherz-Shouval, a former grant recipient who became a principal investigator in the Department of Biomolecular Sciences in 2015.

This year represents two important milestones for Weizmann Canada and its Wonderful Women: the 10-year anniversary of the award program, and the 30-year anniversary of the founding of the Women and Science Committee, established in Toronto by Marvelle Koffler.

Women and Science Committee Chair Michele Atlin and Toronto Chapter President and Vice Chair of the National Board Francie Klein emceed the evening.

L-R: Dr. Ruth Scherz-Shouval, Toronto chapter President Francie Klein, and Committee Chair Michele Atlin.

Weizmann World

Garvan-Weizmann partnership lauded in Australia

The one-year anniversary of the Garvan-Weizmann Centre for Cellular Genomics was celebrated in Sydney at an event hosted by Bob and Ruth Magid on August 2. It was attended by more than 80 supporters and scientists. “We are always hungry to take our basic research expertise and bring it to the next phase to impact humanity, and this is why our collaboration with Garvan is so important and timely... because precision medicine is now the name of the game,” Prof. Israel Bar-Joseph, Vice President for Resource Development and Public Affairs, said in his address.

According to Prof. Chris Goodnow, Executive Director of the Garvan Institute of Medical Research, "DNA sequencing tools that a decade ago I dreamed might one day exist, can now be found inside the Garvan-Weizmann Centre.”

Bob and Ruth Magid with their daughter, Sasha Hoffman (center).

Publishers of *The Australian Jewish News*, the Magids recently donated a major gift to the Garvan-Weizmann partnership. The gift will fund a Magid Family Fellow, a senior scientist in computational cellular genomics.

L-R: Dr. Guy Rothblum and Aharon Aharon, CEO of the Israel Innovation Authority.

Israeli Friends in Tel Aviv

The Israel Association of Friends of the Weizmann Institute of Science brought together the worlds of academia and industry at its latest event, held at the Tel Aviv Hilton on May 22. Dr. Guy Rothblum of the Department of Computer Science and Applied Mathematics spoke about his research on encryption and data privacy in the Information Age. Before joining the Weizmann Institute, Dr. Rothblum was a researcher at Samsung Research America and at Microsoft Research’s lab in Silicon Valley.

Keynote speaker Aharon Aharon, CEO of the Israel Innovation Authority, spoke about nurturing and developing Israeli innovation resources while strengthening the infrastructure of the “knowledge industry.” Mr. Aharon previously served as Apple Israel’s General Manager and VP of Hardware Technologies.

Q&A

Young and inspired in Europe

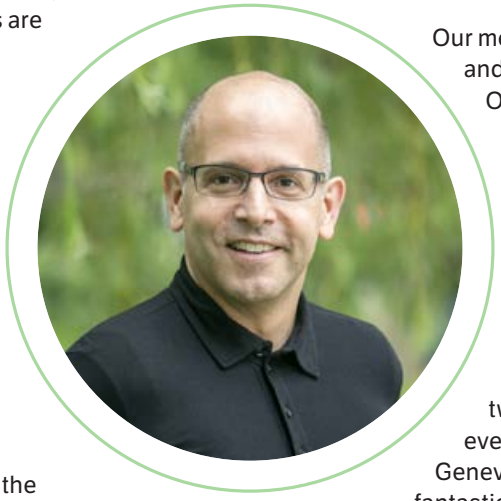
Q&A with Dr. Christian Tidona

Dr. Christian Tidona, 47, is Chairman of the Weizmann Young European Network (WYEN), the next-generation club of the European Committee for the Weizmann Institute of Science and a member of the Institute's International Board. He is Managing Director of BioMed X Innovation Center in Heidelberg, Germany, which offers a new model for fostering biomedical research at the interface between academia and industry, and has has a PhD in molecular biology from the University of Heidelberg.

Q Why join WYEN?

A If you're a young European—aged 25 to 50—and you want to be inspired, network, and learn about state of the art scientific research, think about joining WYEN. Our members are passionate about creating impact, looking for opportunities to meet inspiring peers. They don't necessarily have a background in science and many have never been to Israel before, but they are curious about science and want to know about the "start-up nation."

WYEN brings together people from throughout the European continent to explore the wonders of basic research, meet Weizmann scientists, and learn about the role the Weizmann Institute plays in advancing science for the benefit of humanity. They are usually on the verge of thinking about philanthropy and how to leverage their impact by giving back to society.



Dr. Christian Tidona

Q How does it work?

A Everyone who becomes a WYEN member automatically becomes a member of a Weizmann friends society in the country in which he or she lives, and we hope that our members ultimately get involved in the activities of their local societies. Our board is very international with representatives from all over Europe.

Our members are connected virtually and interact throughout the year. Our events are held about two or three times per year in different locations throughout Europe or Israel. Everyone is a busy professional, so typically our events span half a day and they are filled with inspiration, action, and networking.

Our launch event was in Berlin two years ago, and we've held events in Budapest, Brussels, Zurich, Geneva, and Heidelberg. We've had fantastic speakers—entrepreneurs like Uri Levine, the founder of Waze, and scientific superstars from Weizmann. And we always had amazing venues! What could be better than hearing about the latest scientific breakthroughs at a pool party?

Q What was the impetus for establishing WYEN?

A The young generation of Jews living in Europe and America is not as active in supporting Jewish

Q&A

and Israeli causes as their parents' generation. So, how do we get these young people involved? The answer is: outstanding science and technology. And that broadens our potential base beyond the Jewish community. In Heidelberg, our keynote speaker was Özlem Türeci, one of the most successful biotech entrepreneurs in Europe, who is a Turkish Muslim. Outstanding curiosity-driven research connects people of all cultural backgrounds and beliefs. And the ones who love outstanding science also love the Weizmann Institute.

Q How did you get involved?

A I came to know Weizmann well during my work in developing the biotech network in Heidelberg and initiating collaborations with top institutions outside of our region. I learned that the Weizmann Institute is not just an iconic scientific institution, but that I share its values. In my organization, the BioMed X Innovation Center, we are like a little Weizmann. We only recruit the best of the best. Our approach is to recruit top young research talents worldwide and give them the best resources and freedom to explore. Weizmann scientists from various disciplines don't work in silos—and I know from my own experience that this multidisciplinary approach is the best way to find solutions to the most pressing scientific problems of humanity.

Also, the fact that scientists live on campus is a great thing. Many times, innovation doesn't happen in a lab—it happens during social activities, when bright minds discuss their ideas freely without the need for immediate results. The more talented people with diverse scientific backgrounds you can get in the same place who are looking at the same problem from different perspectives, the more likely you'll find a truly innovative solution.

Q What's up next for WYEN?

A I am looking forward to our four-day retreat in Israel in October. Coming to Israel and being on the Weizmann campus is always an amazing experience. In fact, Tel Aviv is my favorite city. If I were young again, I'd definitely move to Tel Aviv!

Q But you are young! You're part of WYEN!

A Good point. Let's wait and see.

Dr. Liat Ben David

Science literacy front and center in Zurich

The Weizmann Young European Network (WYEN), the next-generation initiative of the European Committee for the Institute, held a luncheon in Zurich on June 5. Dr. Liat Ben David, CEO of the Davidson Institute for Science Education, served as the keynote speaker. Twenty leading Swiss businesspeople heard from her about Davidson Institute programs for the public and in particular for youth and underprivileged children.

Dr. Ben David also met with a group of life science teachers from Zurich high schools. The meeting was organized and hosted by Dr. Samuel Ginsburg, a Swiss Society of Friends board member and a science teacher at the *Gymnasium Kantonsschule Wettingen*. Dr. Ben David shared her philosophy regarding the role of science education, the Davidson Institute's approach to professional development for teachers, and digital learning tools.

Making Connections UK

Celebrating 10 remarkable years

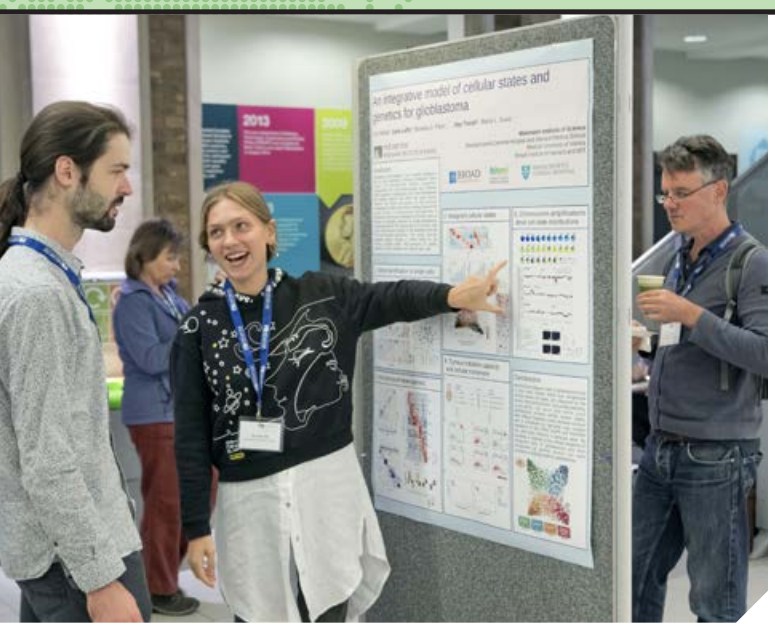
In September, Weizmann UK hosted a two-day symposium on the Making Connections Programme, followed by a spectacular gala dinner attended by nearly 300 guests at the Science Museum in London. The event marked the tenth anniversary of the Programme, which funds scientific collaboration between Weizmann Institute scientists and their UK counterparts. Making Connections has been the major fundraising focus for Weizmann UK for 2018, with nearly $2 million raised to date.

A DECADE IN NUMBERS

- Grants awarded: $4.2m
- Collaborative research projects: 53
- Researchers from the UK and Israel working together: 116
- UK academic institutions involved: 21
- Scientific meetings hosted in the UK and Israel: 8

The Making Connections initiative began in the United Kingdom in 2008, under the chairmanship of Lord Mitchell and thanks to the scientific vision of Prof. Benny Chain. It came about as a positive response to the increasing threat of academic boycotts of Israel. Thanks to the generosity of Weizmann UK supporters, Making Connections has enabled more than 100 researchers from the UK and Israel to pursue joint research. Grants of $100,000 over two years are awarded for each project, with the aim of stimulating substantial longer-term collaborations.

"Making Connections began life as the spark of an idea," says Sheridan Gould, Weizmann UK Executive Director. "It is with enormous pride that we celebrate this milestone of what has grown into a flourishing program of collaboration between the Weizmann Institute and UK universities."



Making sense of complexity: *A systems biology symposium attended by about 150 scientists was hosted at University College London. The program was jointly organized by Prof. Benny Chain (UCL), Prof. Charles Swanton (Francis Crick Institute), and Prof. Uri Alon (Weizmann Institute).*

Cocktail of science: *Weizmann scientists and their UK colleagues attended the Making Connections gala in London. Guests had the opportunity to mix and mingle with scientists during the reception to learn about the fascinating questions their research projects address.*

Exploring the great unknowns: *In the spirit of collaboration, the keynote speakers, Prof. Uri Alon (Weizmann Institute, pictured at left) and Prof. Marcus du Sautoy (University of Oxford, at right), delivered a highly entertaining scientific and musical exploration of how scientists push the boundaries of knowledge.*

A special tribute: *After nearly 10 years as Chairman of Weizmann UK, Martin Paisner CBE (pictured at left) is stepping down this year. Dr. Arabella Duffield (right) will take on the role of Chair. Martin was offered heartfelt thanks for his extraordinary commitment to the Weizmann Institute that has spanned more than 40 years.*

Brazil's Oncoclinicas makes a campus visit

On July 2, the Latin American Committee for the Weizmann Institute hosted a campus tour for Dr. Bruno Ferrari, Dr. Carlos Gil, and Prof. Mariano Zalis of Oncoclinicas, the largest oncology, hematology, and radiotherapy conglomerate in Latin America, to showcase Weizmann research on cancer. They met with Prof. Moshe Oren, Director of the Moross Integrated Cancer Center and visited the Nancy and Stephen Grand Israel National Center for Personalized Medicine.

L-R: Dany Schmit, CEO for External Affairs, Latin American Committee, Prof. Israel Bar- Joseph, Vice President for Resource Development and Public Affairs, Dr. Bruno Ferrari, Prof. Mariano Zalis, and Dr. Carlos Gil.

Her story: Andrea Klepetar Fallek

Andrea Klepetar Fallek (left) with former Institute president Prof. Haim Harari and his wife Elfi.

At age 98, Andrea Klepetar Fallek sat down to write her memoirs, *My Story,* and found she had much to say. Born in Austria in 1920, she moved to Yugoslavia on the eve of World War II. She survived the Holocaust while crisscrossing through Yugoslavia, Croatia, and Italy, but her first husband was killed. Ms. Klepetar Fallek continued to move around throughout her life, arriving in Israel in 1948; she has also lived in Argentina, Switzerland, and, in recent decades, New York City. She married three more times, and maintains a network of friends across the globe.

As described in her memoirs, her experiences culminated, in part, with a friendship she began with the Weizmann Institute two decades ago. She and her late husband Fred Fallek established a professorial chair for Prof. Hadassa Degani, of the Department of Biological Regulation. That decision was taken after Ms. Klepetar Fallek became interested in the scientist's work on a non-invasive, MRI-based method to detect breast and prostate cancers, which, after FDA approval, became accepted protocol for detection of these cancers worldwide.

"I became very enthusiastic about [this] wonderful organization," she writes. "My connection to the Weizmann Institute became very important to me and very positive."

A close friend, who penned the book's preface, wrote of Ms. Klepetar Fallek: "Philanthropy comes with a mantle of responsibility and Andrea wears it well. She exemplifies what it means to give. It is not only that she is a generous supporter of the arts but that she puts her gifts where her heart and ideas live."

Alumni for hire: Annual career fair

On May 10, the Weizmann Alumni Organization's annual career fair, held at the David Lopatie Conference Centre, brought together 24 companies in life and exact sciences with some 250 students and recent alumni. Many of the company representatives were also Weizmann alumni.

Scientists of Tomorrow visit Argentina and Brazil

A mission of three Weizmann Institute PhD students led by Kelly Avidan, Director of the Department of Resource Development, traveled to Argentina and Brazil in April, as part of the Scientists of Tomorrow program, for a series of talks and meetings with donors and friends. The group met with supporters at a series of companies, organizations, schools, and private residences. The mission's students were Michal Shaked of the Department of Molecular Cell Biology, Rafael Stern of the Department of Earth and Planetary Sciences, and Andres Goldman of the Department of Biological Regulation.

L-R: Rafael Stern, Kelly Avidan, Michal Shaked, and Andres Goldman.

"Our aim was to bring a taste of the Weizmann Institute to our friends in Latin America, raise awareness around the kind of superior science being carried out at Weizmann, and describe how Weizmann is training Israel's best minds in science," says Ms. Avidan.

The group was hosted by new friends and old, both in Buenos Aires and São Paulo.

"Listening to young scientists from Weizmann is a source of inspiration and hope that we can make the world a better place," says Mario Fleck, President of the Brazil Friends of the Weizmann Institute of Science.

When math becomes music

Mastering piano, thanks to algorithms

L-R: Yigal Kaminka, Yuval Kaminka, and Roey Izkovsky.

Yuval Kaminka is determined to bring live music into homes around the globe—from one-handed piano melodies like Beethoven's *Ode to Joy* to more complex renditions of today's pop chart favorites.

Kaminka, a Weizmann Institute computer science alumnus, is the CEO and co-founder of the Tel Aviv-based JoyTunes. JoyTunes' piano-learning apps are its key products (pun intended) and the company plans to expand them to include other musical instruments. Placing a tablet or mobile phone on their piano's music rack, users can launch one of three JoyTunes apps that instantly enable their device to recognize the notes they are playing.

The company's three main products include Piano Maestro, an in-depth educational app used by teachers to accompany traditional lessons; Simply Piano, a step-by-step program for self-learners; and Piano Dust Buster, a playful introduction to piano for kids. All require a subscription.

"In every household, you'll find someone who dreams about jamming on the guitar or someone who played piano at one point and wants to get back to it," Kaminka says.

While the apps teach piano students, they aren't meant to replace teachers. Instructors can use Piano Maestro in a variety of ways: as a special activity for their students during their lessons, for homework assignments, or as a digital method book. Simply Piano takes a linear approach—watch videos, complete exercises, play songs. About 30 seconds after learning their first three notes, students play a simple song, and about an hour later, they're on to a version of *Jingle Bells* with two hands.

Rather than disrupting traditional music education, JoyTunes aims to break down the mental block that

Alumni

often prevents people from casually trying out an instrument, says Kaminka.

The app's core technology is its acoustic recognition engine, which is able to distinguish each note that a user plays—transforming an ordinary smartphone into a powerful ear that sifts through sounds and provides instant feedback. Its main challenge is coping with "real life" conditions outside the laboratory, such as the restrictions posed by a single microphone, the presence of background noise, and the highly limited performance abilities of standard mobile devices. All the while, the app must precisely identify both single notes and chords (polyphonic recognition) through a "music sense" system that combines machine learning, neuro-linguistic programming, and acoustic recognition.

Kaminka came up with the idea for JoyTunes after watching his nephew happily playing video games but protesting the idea of practicing piano.

"We thought we'd take something very tedious and mechanical, and make it fun," he says.

Thinking like a scientist, he started brainstorming how computer algorithms might be able to help. Kaminka received his MSc from the Institute in 2009, under the supervision of Prof. Shimon Ullman from the Department of Computer Science and Applied Mathematics and Dr. Elad Schneidman from the Department of Neurobiology.

During his studies, Kaminka says he read several published papers on human computation—how the mind does wondrous things but also benefits from extensive training. This sparked his interest in music learning and self expression through music, as well as how these skills could be cultivated. He started JoyTunes in 2010 with Roey Izkovsky, who became its Chief Technology Officer; Izkovsky is also a Weizmann Institute alumnus, who earned his MSc in 2007 under Prof. Itai Benjamini in the Department of Mathematics.

At the company's headquarters, visitors will find a glossy upright piano in an eclectic lobby festooned with musical trinkets. Along an exposed brick wall, a record stylus keeps time on a vintage vinyl clock, while a giant poster of cassette tapes hangs behind the communal dining table.

While Kaminka briefly dabbled in both violin and saxophone, Izkovsky has no musical background. But the concept was music to his ears, and he is responsible for the company's acoustic recognition technology. The third co-founder and musical director, Kaminka's brother Yigal, was the principal oboist in the Jerusalem Symphony Orchestra.

Singing praise

The company has won accolades from experts in the field. Eran Egozy, co-founder of Harmonix Music Systems (which put out Guitar Hero and Rock Band), and currently a music professor at MIT, says he sees JoyTunes "as a shining example of a very successful music startup."

"JoyTunes has created a powerful platform," he adds. "The result is a fast growing community of piano students and teachers that is rekindling the joy of playing piano."

Linda Christensen, a piano instructor at a school in Maryland, credits JoyTunes for changing "the face and culture of piano teaching." She adds, "The Piano Maestro app in particular has allowed teachers to incorporate technology easily, allowing for dynamic engagement between teacher, student, and parent."

Particularly appreciative of the collaborative culture of critical thinking on the Weizmann campus, Kaminka says he makes sure to encourage his employees to ask tough questions.

"I very much liked the idealism of science there—the openness of the community, of sharing knowledge, and this common goal of advancing science," he adds. "We like to take that into the company."

Science moves fast; teachers must too

A decade of the Rothschild-Weizmann Program in science teaching

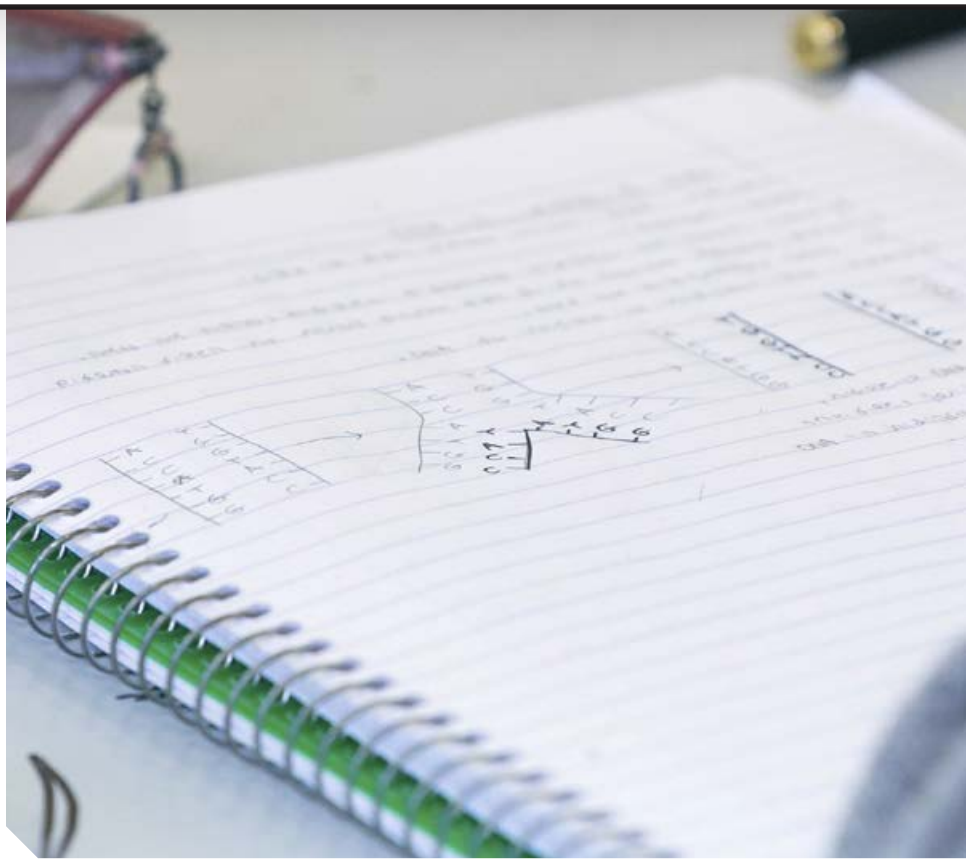
Science and technology are advancing at breakneck speed. It is therefore critical for teachers to be up to date with current innovations and to effectively integrate this knowledge into their classrooms. With this in mind, the Institute initiated the Rothschild-Weizmann Program for Excellence in Science Teaching in 2008, with the support of the Edmond de Rothschild Foundations, using a "teach the teachers" approach to raise the quality of science education in Israel. Recently, the program received a major gift of support from the Morris and Rosalind Goodman Family Foundation of Canada.

Ten years later, the program has become a model for advancing the academic and professional development of science and math teachers in Israel, cultivating a new generation of teachers to act as "science ambassadors" in their own schools and communities.

High school science teacher Nadav Caspi

Education

48–49



The program was initiated by the Department of Science Teaching as part of its mission to give teachers the tools to keep up with new trends in science and advance the level of science education in Israel. The program is co-headed by Prof. Shimon Levit from the Department of Condensed Matter Physics and Prof. Bat-Sheva Eylon from the Department of Science Teaching.

"Our immediate goals with this program were to empower science teachers and increase their motivation by providing them with unique opportunities to expand their knowledge," says Prof. Eylon.

The program has two tracks: studies toward an MSc degree (non-thesis) in science teaching, and a post-MSc professional development track. The latter is aimed at teachers with MSc or PhD degrees in science or science education and alumni of the program's MSc track who wish to enrich their teaching skills and pedagogical knowledge.

The MSc program exposes teachers to cutting-edge research taking place in Weizmann Institute laboratories, to contemporary topics in general science, and to innovations in science education. In addition, both during and after completion of their studies, participants receive assistance from Institute scientists and educational staff as they initiate projects for implementation in the field.

About 30 teachers are enrolled every year, with a focus on one of four disciplines: biology, chemistry, mathematics, and physics. To date, 253 teachers have received their MSc degrees through the Rothschild-Weizmann Program, and participants hail from 130 localities throughout Israel representing diverse populations and social groups—urban and rural, religious and secular, Jewish and Arab. Program graduates go on to serve in a variety of enhanced educational leadership roles.

The impact is felt immediately. "Ninety-eight percent of participants continue to teach after graduating and the majority say that the scientific and pedagogic knowledge they gained in the program has led to significant changes in their teaching practices," says Prof. Eylon. About three quarters of the students taught by teachers who have gone through the program reported a noticeable difference in the approaches their teachers employ in the classroom.

"The program has enriched my knowledge in many relevant fields, among them molecular biology and bioinformatics," says one alumna, Tirza Gidron, from Tiberias. Merav Ben David, from Ashkelon, adds: "The Rothschild-Weizmann Program provided me, in a practical and thorough way, pedagogic tools in a range of subjects, which I now employ in my classroom."

*i*Science

Enter the virtual classroom

"When someone comes in from the outside with the title of doctor, students perk up and want to listen," says Shiran Malka, a junior high school science teacher. "It gets them motivated."

50–51

Across Israel, Weizmann scientists are popping into classrooms—virtually—to engage in vibrant conversation with students and teachers about the marvels of science. "I feel it's a service and a calling that we as scientists should take part in," says Prof. Ron Milo, of the Weizmann Institute's Department of Plant and Environmental Sciences. Prof. Milo and his colleagues—most of whom are Institute researchers and alumni—are participating in an innovative program called *i*Scientist, run by Weizmann's Davidson Institute of Science Education. Through this virtual interface, scientists are conducting informal discussions with junior high and high school students and their teachers. These live video chats provide participants throughout Israel with the rare experience of connecting with and learning from world-class researchers and cultivating students' interest in science.

The initiative is part of a broader project spearheaded by the Davidson Institute called *i*Science, which includes several programs aimed at engaging students, teachers, and the public by leveraging today's sophisticated online technologies. The other tracks are *i*Lab, which provides teachers with high-quality tools that deepen the classroom learning experience; *i*Student, which provides curricular and extracurricular materials to students; *i*Teacher, which offers formal online professional development courses for teachers; and *i*Public, which focuses on boosting media coverage of science news and providing educational courses for the public.

An *i*Scientist mobile phone app enables teachers to easily search for relevant scientists, read background material, and coordinate video conversations. Teachers can select who they want to "host" in their classrooms through the app's profiles of scientists, which feature two-minute videos wherein they talk about themselves and their research.

Aiming to raise questions among students prior to the virtual chats, *i*Scientist also includes preparatory lessons developed by the program's staff members. Though *i*Scientist is still a work in progress, the development team has already completed many lessons to match specific research topics, and is now building a generic lesson plan for broader use.

Teachers and students who have already participated in the pilot stages have been responding with enthusiasm. Ofira Kashany, a seventh and eighth grade science coordinator at the Hemdat Hadarom Academic College of Education, says that young students can gain long-term benefits from these conversations. For example, one of Kashany's students asked a female researcher if she was among the only women working in electron microscopy.

Shiran Malka, a junior high school science teacher at Haifa's Kiryat Haim High School, finds that not only do the students gain exposure to new subjects, but they also learn about the daily life of a researcher.

"The children have the opportunity to understand what a professor is, what a doctor is," Malka says. "And when someone comes in from outside with the title of doctor, students perk up and want to listen. It gets them motivated."

Thus far, *i*Scientist has held nearly 70 sessions. More than 100 scientists have committed to participating in the program—the majority from the Weizmann community, but some outside scientists as well.

Meirav Bass, head of *i*Scientist, says that "the program is unique because it enables an unmediated connection between scientists and students of all ages and with all levels of knowledge, all over the country. It also gives students access to role models and opens their eyes to science and scientists."

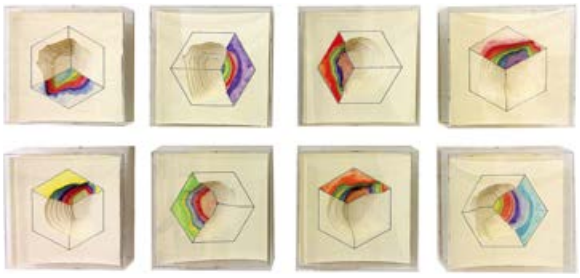
The Davidson Institute plans to roll out other *i*Science programs in the coming years.

Five floors of art

Nine artists exhibit at the Stone Administration Building

The work of nine Israeli artists, including several Weizmann scientists, are on display in an exhibit curated by Yivsam Azgad, Director of Media Relations.

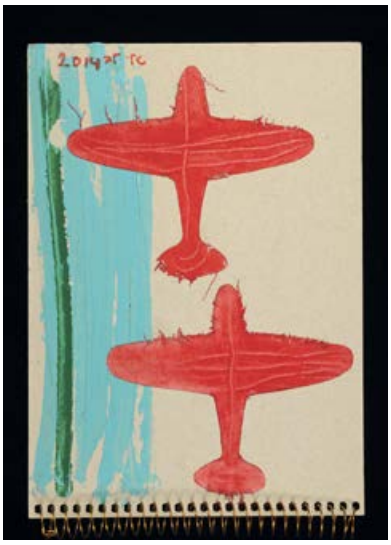
From "Yesterday's News," by Ariela Saba



"Spectrum Hexagon," by Maty Grunberg

Digital art, by Or Raviv

"A Race to America," by Joshua Griffit



From "Unraveling Planes," by Tali Lev

From "Small Birds," by Nuli Omer

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Quantum Theory

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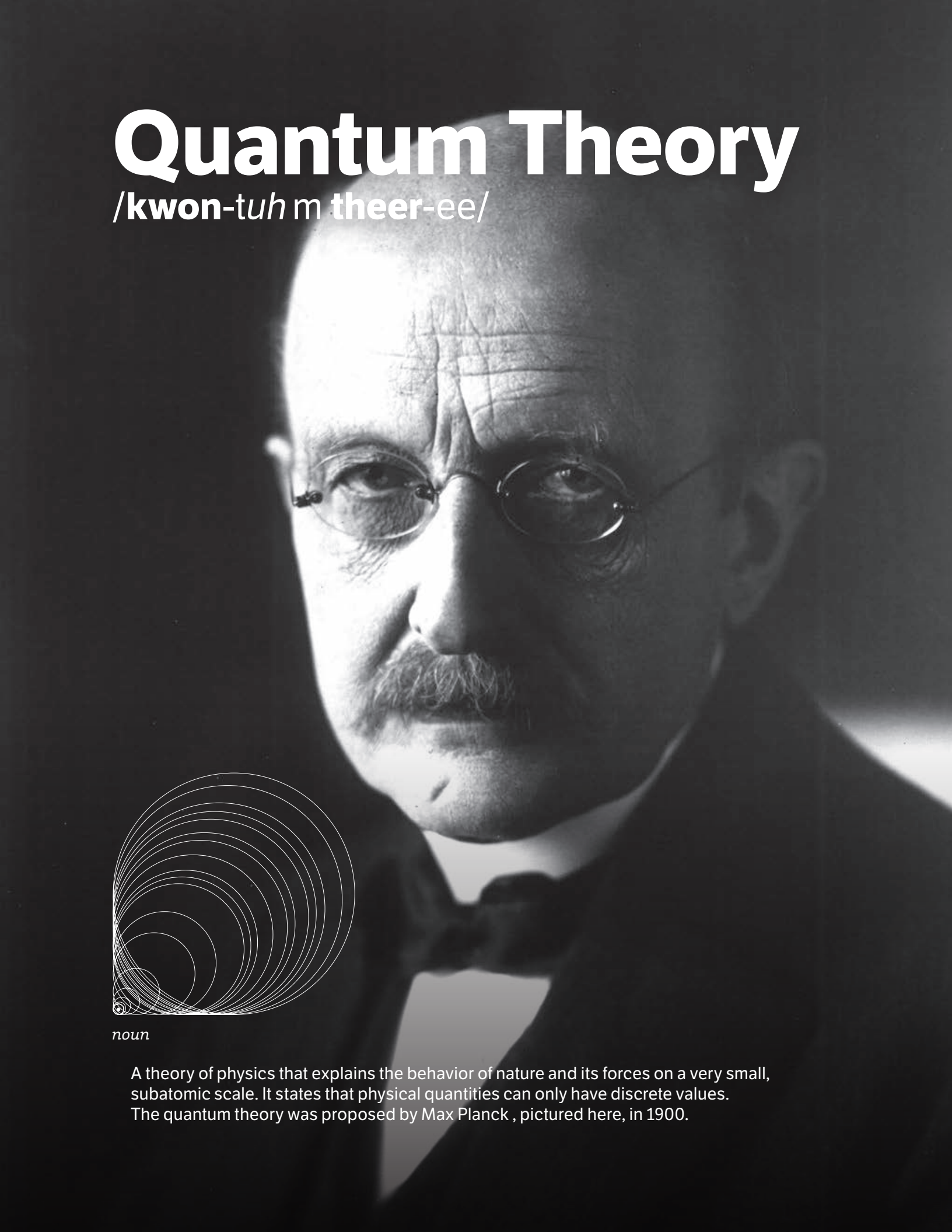

noun

A theory of physics that explains the behavior of nature and its forces on a very small, subatomic scale. It states that physical quantities can only have discrete values. The quantum theory was proposed by Max Planck , pictured here, in 1900.