TECHNION

FOCUS

DECEMBER 2019

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From left: Prof. Gideon Grader, Avigail Landman, Prof. Avner Rothschild and Dr. Hen Dotan

CLEAN **POWER**

Technion researchers have developed an inexpensive, environmentally friendly and safe hydrogen production technology. A start-up called H2Pro is now working on commercializing this revolutionary discovery.

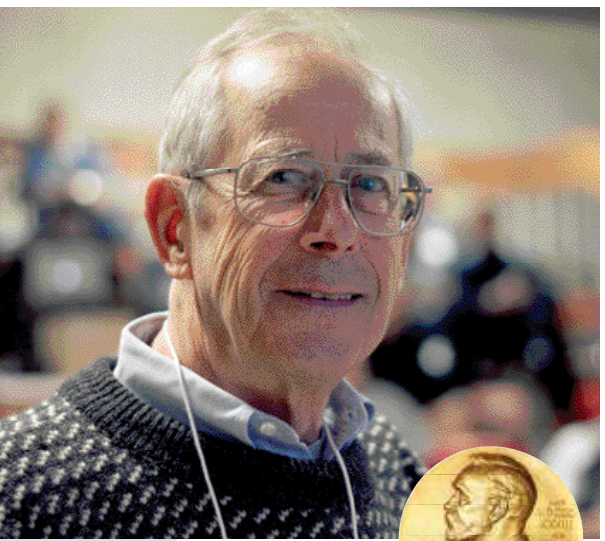
The research, part of the Nancy and Stephen Grand Technion Energy Program (GTEP), was conducted by Prof. Avner Rothschild of the Faculty of Materials Science and Engineering and Prof. Gideon Grader of the Wolfson Faculty of Chemical Engineering, together with Dr. Hen Dotan and doctoral student Avigail Landman. Their findings were recently published in *Nature Energy*.

The groundbreaking technology, called E-TAC (Electrochemical–Thermally-Activated Chemical) water splitting, is based on a cyclic process in which the chemical makeup of the anode (the electrode where the oxidation process takes place) changes intermittently. The new technology, which decouples the hydrogen and oxygen evolution reactions, significantly improves the efficiency of hydrogen production, from ~75% using current methods to an unprecedented 98.7% energy efficiency.

Following this breakthrough, the researchers founded H2Pro, a start-up company located in the Caesarea Industrial Park that is working on converting the technology to a commercial application. H2Pro has more than 20 employees, most of them Technion graduates, and has raised over $5 million so far.

The research is supported by the Nancy and Stephen Grand Technion Energy Program (GTEP), the Ed Satell gift for Nitrogen-Hydrogen Alternative Fuels (NHAF), the Adelis Foundation, the Israel Ministry of Energy, and the European Commission (EU Horizon 2020 Framework Program).

FOCUS on sustainability: page 4



Prof. James E. Peebles

FROM **HARVEY** TO **NOBEL**

The prestigious Harvey Prize for science and technology was awarded at Technion in early November to Profs. Emmanuelle Charpentier, Jennifer Doudna and Feng Zhang, who developed the groundbreaking genetic editing technology CRISPR-Cas9, and to Prof. Christos H. Papadimitriou, a founding father of algorithmic game theory.

"More than a quarter of Harvey laureates have subsequently won a Nobel"

It was recently announced that Prof. James E. Peebles, 2001 Harvey Prize laureate, will be awarded the 2019 Nobel Prize in Physics. The Harvey Prize frequently portends the Nobel Prize, as more than a quarter of Harvey laureates have subsequently won a Nobel over the years. In the last three years alone, five Harvey Prize winners have received Nobel Prizes.

Meet this year's Harvey Prize winners: **Prof. Emmanuelle Charpentier** from the Max Planck Institute and **Prof. Jennifer Doudna** from UC Berkeley published their historic article in 2012 in the prestigious journal *Science*, describing how the bacterial protein CRISPR-Cas9 can identify targets in the DNA and can be easily programmed to edit a broad range of DNA targets. These dramatic discoveries generated a revolution in life sciences and are expected to spark the development of innovative treatments for diseases.

"It is a great honor for me to receive this prize, and I thank Technion for acknowledging the importance of our

Continued on page 2

EMET PRIZE TO PROF. MOTI SEGEV

Distinguished Prof. Mordechai (Moti) Segev of the Faculty of Physics has won the 2019 EMET Prize in the Exact Sciences "for his groundbreaking achievements in the research of nonlinear optics, most notably the pioneering experiments on two-dimensional solitons, as well as his demonstration of the first photonic topological insulators, which launched the new field of topological photonics."

One of the world's leading researchers of the interactions between light and matter, he had profound impact on optics, photonics and other areas in physics, and his work has impacted numerous fields beyond optics, ranging from applied mathematics and condensed matter physics to the research of ultra-cold atoms.

Prof. Segev has won numerous prestigious awards, among them the Quantum Electronics Prize of the European Physics Society (2007), the Max Born Award of the American Optical Society (2009), the Arthur Schawlow Prize in Laser Science of the American Physical Society (2014), and the Israel Prize in Physics (2014). Segev is a foreign member of the United States National Academy of Sciences and a member of the Israel Academy of Sciences and Humanities.

Beyond his personal achievements, Segev is most proud of the success of his doctoral and postdoctoral students, 21 of whom are university professors in Israel and abroad, as well as many others who hold senior R&D positions in industry. His candidacy for this year's EMET Prize was submitted by his former students, who are now university professors in Israel.

Prof. Mordechai Segev is the Robert J. Shillman Distinguished Professor of Physics

In this issue...

FROM TECHNION PRESIDENT PROF. URI SIVAN

Prof. Uri Sivan *(r)* was inaugurated as the new President of Technion at the end of September. Peretz Lavie *(l)* hands over the gavel.

I started my tenure as President of Technion just as the university kicked off the new academic year with the largest student enrollment in its history. The student body now comprises 16,500 students, of whom 12,250 are undergraduates and some 4,270 are graduate students.

Nearly a century has passed since Technion opened its doors with a class of 17 students. Since then, it has educated over 80,000 engineers, researchers and doctors, whose tremendous contributions to the state and society can be found everywhere. Technion fosters co-existence within Israeli society, and the education our students receive enables them to improve society and the quality of life worldwide for present and future generations. Indeed, I hope that during their studies at Technion, the large current cohort of students will imbibe the universal values of equality, pluralism, tolerance and the pursuit of truth, which are the breath of academic life.

The great challenges of the 21st century – human health, energy, environment, sustainability, advanced manufacturing and education – require a multidisciplinary approach and the ability to create the necessary synergy to meet these challenges. These pages contain news about some of the most extraordinary scientific breakthroughs that took place at Technion in the last few months alone, including remarkable discoveries in the field of health. Not surprisingly, many of these breakthroughs involve multidisciplinary collaborations – for example, members of our Faculty of Computer Science worked with medical doctors to develop a new technology for improving personalized cancer treatment. I have no doubt that in the future this multidisciplinary approach will increasingly become the norm.

A special section of this issue is devoted to Technion's commitment to the challenge of sustainability. In addition to encouraging our scientists to conduct research that can improve the environment, it is our responsibility to educate our students in this field and to improve the level of sustainability on campus. I would like to take this opportunity to wish the entire Technion community a rewarding and meaningful academic year.

Uri Sivan

FOCUS

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Director, Division of Public Affairs and Resource Development: Gil Lainer
Head, Public Affairs: Yvette Gershon
Editor: Rebecca Kopans
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Design: CastroNawy
Photo Coordinator: Hilda Favel
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Technion – Israel Institute of Technology
Haifa 3200004, Israel
public@technion.ac.il
www.youtube.com/Technion

From left: Prof. Feng Zhang, Prof. Christos H. Papadimitriou, Prof. Emmanuelle Charpentier, Prof. Jennifer Doudna

Continued from page 1

FROM **HARVEY** TO **NOBEL**

Harvey Prize Honors CRISPR-Cas9 and Game Theory

research," said Prof. Charpentier at the ceremony. Prof. Doudna added in a taped video clip (as she was not able to attend in person): "Today, CRISPR-Cas9 is used by scientists around the world to develop treatments for genetic diseases and to repair agricultural damage caused by global warming."

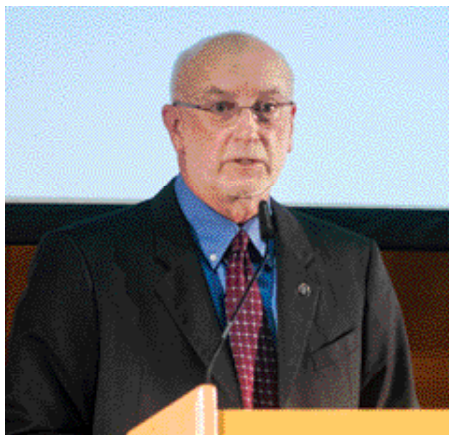
Prof. Feng Zhang of MIT's Broad Institute published a landmark article on CRISPR-Cas9 technology in *Science*. Prof. Zhang, who is 38, is the youngest person ever to win a Harvey Prize. "I feel very humbled to receive this award from Technion. The science here is topnotch and people here are all very passionate about science," Prof. Zhang told *FOCUS*.

The winner in the field of Computer Science, **Prof. Christos H. Papadimitriou** from Columbia University, is best known for his work on computational complexity. Prof. Papadimitriou said at the ceremony that, "25 years ago, Computer Science's center of gravity shifted from the computer itself to the Internet. This process led to studies that were crucial for the development of science, for improving humanity and for understanding the universe. I'm happy that I was able to participate in these developments and to work with outstanding researchers from Technion."

The Harvey Prize, which was established in 1971 by Leo M. Harvey of Los Angeles, is awarded annually at Technion for exceptional achievements in science, technology and human health.

Congratulations!

NEW CHAIRMAN OF THE BOARD



Scott Leemaster

Scott Leemaster of Franklin, Michigan is the new chair of the Technion Board of Governors. He assumed the post in June during the Board's annual meeting, succeeding long-time chair Lawrence Jackier.

"I am deeply honored to take on this new role and grateful for the opportunity to continue my life-long love affair with Technion and its people," Mr. Leemaster said. He became involved with the American Technion Society (ATS) in the late 1990s, driven by the Jewish value of *tikun olam*, Hebrew for repairing the world. "Technion improves the lives of people around the world through its innovative solutions in science and technology," he explains.

Mr. Leemaster became active on the ATS National Board of Directors in 2005, chaired numerous committees, including the Audit Committee, and in 2012 became ATS president. During his tenure, he presided over the launch of the organization's half-billion-dollar fundraising campaign, "Innovation for a Better World." Most recently, he has served as the national chairman of the board.

Scott Leemaster is vice president and principal of Madison Electric Company. He and his wife Susie are Technion Guardians, and have generously funded a number of projects, including the Departmental Library in the D. Dan & Betty Kahn Mechanical Engineering Building and the Shared Core Facility in the Sohnis and Forman Families Center of Excellence for Stem Cell and Tissue Regeneration Research. In 2009, Mr. Leemaster was awarded a Technion Honorary Fellowship for his generosity and his hands-on involvement.

RISING TECHNION

ZISAPEL BROTHERS FUND NEW BUILDING FOR ELECTRICAL ENGINEERING

The cornerstone was recently laid for a new building for the Andrew and Erna Viterbi Faculty of Electrical Engineering, which will be built thanks to a generous gift by brothers Yehuda and Zohar Zisapel, founders of the RAD Bynet Group, who are both alumni of the Faculty.

The Viterbi Faculty of Electrical Engineering is Technion's largest faculty and the largest engineering department in Israel, with over 2,200 students. The new Zisapel Electrical Engineering Building will be located between the faculty's two existing buildings and will provide a huge boost to Technion's teaching and research facilities. It will also function as a hub for basic and applied research for training scientists, students and engineers, and for developing advanced technologies.

From left: Prof. Peretz Lavie, Yehuda Zisapel and Zohar Zisapel

Irith Rappaport *(left)* and Dr. Vered Drenger at the cornerstone-laying ceremony

MEDICAL RESEARCH BUILDING **GIFTED BY THE RAPPAPORT FOUNDATION**

The Bruce and Ruth Rappaport Foundation has made a transformational gift to Technion for the establishment of the Rappaport Integrative Cancer Research Center and the Rappaport Building for Advanced Medical Research adjacent to the Ruth and Bruce Rappaport Faculty of Medicine.

The cornerstone-laying ceremony for the Rappaport Building for Advanced Medical Research took place in the presence of Ms. Irith Rappaport and Dr. Vered Drenger, daughters of the late Ruth and Bruce Rappaport; Nobel Laureate Distinguished Prof. Aaron Ciechanover; and other distinguished guests. The contract for the establishment of the Rappaport Integrative Cancer Research Center was signed at the ceremony. Ruth and Bruce Rappaport were philanthropists whose magnanimous support enabled the creation of the Rappaport Medical Faculty Building and the Rappaport Institute for Research in the Medical Sciences at Technion.

JAPAN & ISRAEL: **Scientific Synergy at Technion**

The Israel-Japan Conference on Molecular Catalysis in the Service of Society, which recently took place at Technion for the first time, is expected to pave the way for increased binational scientific collaborations in the field of sustainable chemistry. The conference, which brought together renowned researchers from Japan and Israel, was organized by Distinguished Prof. Yitzhak Apeloig, holder of the *Nahum Guzik Distinguished Academic Chair*; Prof. Zeev Gross, holder of the *Reba May Blum and Robert D. Blum Jr Academic Chair*; and Prof. Ilan Marek, holder of the *Sir Michael and Lady Sobell Academic Chair*, all from Technion. The Japanese delegation included scientists from Tokyo University, Kyoto University, Osaka University and other top Japanese institutions. Japanese Ambassador to Israel Koichi Aiboshi hosted a reception in honor of the participants.

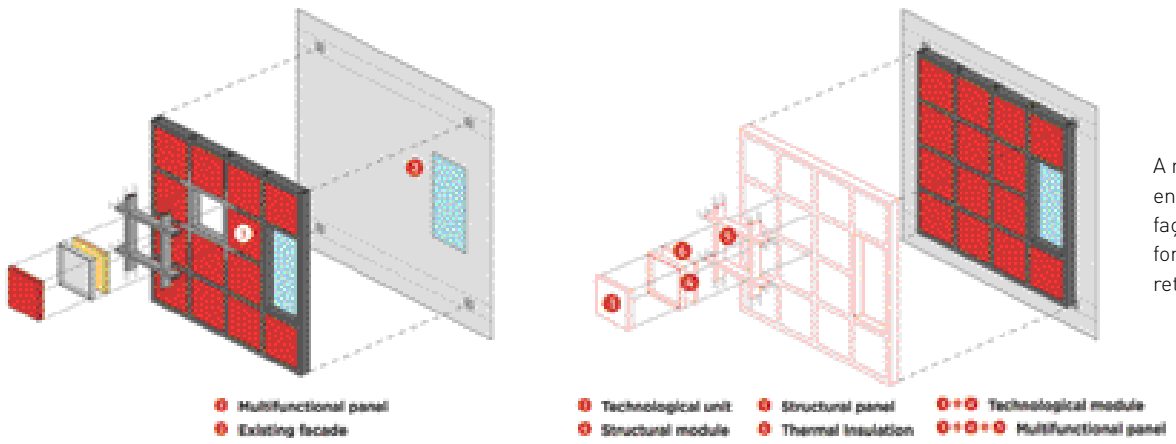
(Below) Japanese Ambassador to Israel Koichi Aiboshi *(5th from right)* at Technion with the participants of the Japan-Israel Conference on Chemistry

SCIENCE OF SUSTAINABILITY

By Rebecca Kopans

Sustainability has become an international mantra, expressing hope that a looming disaster can be averted if only everyone would behave more responsibly. In almost every aspect of our lives, it is essential to improve current standards in order to meet reasonable goals of sustainability. Technion is determined to take the reins in this area – prioritizing scientific research in relevant fields and breathing life into its Green Campus initiative. Many of the challenges of sustainability are scientific and at Technion, scientists and researchers are anticipating the future with basic research and applied ingenuity.

From alternative energy to waste management, ecological architecture, 'green' transportation, eco-friendly food and more, Technion researchers are engineering new forms of global responsibility.



A multifunctional energy efficient façade system for building retrofitting

Life Cycle Assessment

At the Faculty of Civil and Environmental Engineering, Prof. Sabrina Spatari is an expert in Life Cycle Assessment. This is an analytical framework used for evaluating environmental impact which supports decision-making, especially when selecting materials for manufacturing products. The technique evaluates all stages of a product's life: raw material extraction, materials processing, production, distribution, use, repair and maintenance, and disposal or recycling.

"In the last 10-15 years, Life Cycle Assessment has been used to set energy policies in the U.S. and Europe, for example with the goal of replacing gasoline with renewable fuel," Prof. Spatari explains. "We look at the fuel's full life cycle, including the energy used for extraction, the resources consumed and the emissions to the environment."

Prof. Spatari researches sustainability issues in a variety of fields, including 'green' transportation, construction and electricity. She recently published a paper on "Life Cycle Environment and Cost Implications of Isostearic Acid Production for Pharmaceutical and Personal Care Products" in the journal *ACS Sustainable Chemistry & Engineering*. Having recently moved to Israel, Prof. Spatari sees the potential to greatly decarbonize Israel's economy through investment in solar energy in its buildings within cities.

Prof. Sabrina Spatari holds a Women's Division Career Advancement Chair.

Prof. Sabrina Spatari

Prof. Guedi Capeluto

Zero-energy buildings

"Thirty years from now, Israel's population will double, and we must therefore double the physical space. The challenge lies in both the quantity and the quality," says Prof. Guedi Capeluto of the Faculty of Architecture and Town Planning. Prof. Capeluto is a former Chair of the Architecture Program and has been involved with sustainable architecture for many years. "We must plan buildings that are energy efficient," he says.

> "My dream is that we will have a zero-energy campus by 2030"

Working on a national and global level, Prof. Capeluto is a founder of the Climate and Energy Laboratory and a member of the Israeli Climate Change Information Center. He has developed the official Energy Rating System for Buildings in Israel, which ranks buildings according to their expected energy performance and which is used in order to accredit green buildings. "Buildings must be planned with maximum natural lighting and minimum pollution," he maintains. Prof. Capeluto has also helped develop several innovative systems to improve the energy efficiency of existing buildings. He was recently involved in an international consortium that designed a multifunctional energy efficient façade system for retrofitting buildings. Another project uses a lightweight structural mesh system to save as much as 60% of a building's energy. Both systems are currently being tested at sites in Europe.

"Technion can be a leader in this field. We have an opportunity to lead change and put Technion on the map as a sustainable institution," asserts Prof. Capeluto. "My dream is that we will have a zero-energy campus by 2030. We must insist that all new Technion buildings meet green standards." Since Technion trains Israel's future architects and urban planners, he believes it is imperative for all students to be exposed to the subject as much as possible during their studies. He is especially proud of the fact that there is now a leading Master's program in Green Architecture offered at the Faculty.

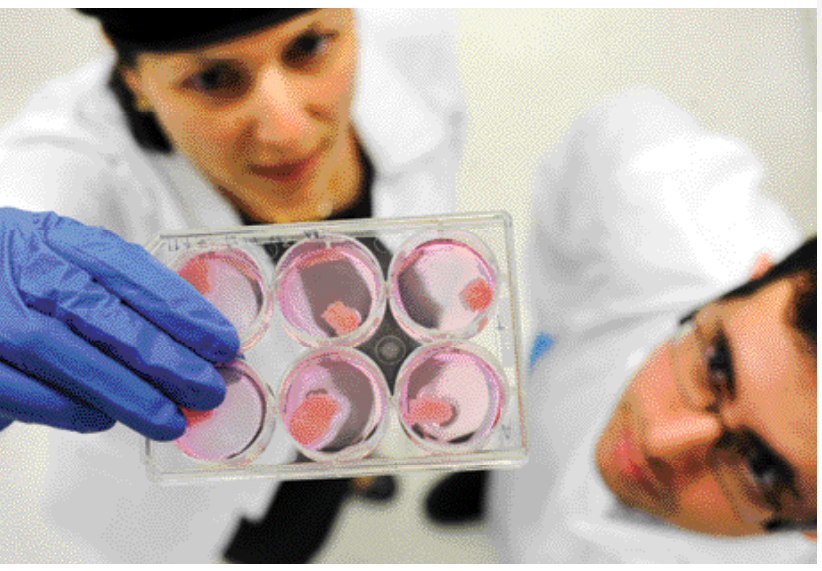
Green transportation

Prof. Karel Martens, Chair of the Urban and Regional Planning program at the Faculty of Architecture and Town Planning, approaches the field of sustainability by studying transportation through the lens of justice. In his research, he develops a new approach to transportation planning. In contrast to the traditional method, Martens' approach does not aim to optimize the functioning of the transportation system but, rather, seeks to provide a

Prof. Karel Martens

well-functioning transportation system that serves everyone, irrespective of people's abilities, income or background.

Prof. Martens believes that Technion should be a leader in socially responsible transportation. "The university should give clear preference to green modes of transportation by making the campus more convenient for pedestrians, giving priority to buses and providing incentives for faculty and students to leave their cars at home," he asserts, adding that, "Parts of the campus could be closed to traffic and parking lots can be moved away from buildings in order to make car use less attractive."



Prof. Shulamit Levenberg is developing the next generation of laboratory-produced meat

Laboratory-produced 'clean meat'

Environmentalists lament the fact that greenhouse gases produced by the meat industry are responsible for more emissions than all methods of transportation combined.

Prof. Shulamit Levenberg, Dean of the Faculty of Biomedical Engineering, is the chief scientific officer of Aleph Farms, a Technion research-based start-up aiming to produce the next generation of laboratory-produced meat. An expert on tissue engineering, she is responsible for important breakthroughs in producing human tissue outside the body for use in restoring damaged tissue. Taking this technology one step further, Prof. Levenberg and her colleagues were able to create a steak from bovine cells. Slaughter-free meat involves taking a sample of cow cells and replicating them outside of the animal: without the antibiotics, environmental footprint, contamination and animal death which comes with conventional meat production. Thanks to Prof. Levenberg's pioneering work, Technion is part of the global effort to develop sustainable alternatives to animal meat.

Prof. Shulamit Levenberg is holder of the Stanley and Sylvia Shirvan Chair in Cancer and Life Sciences.

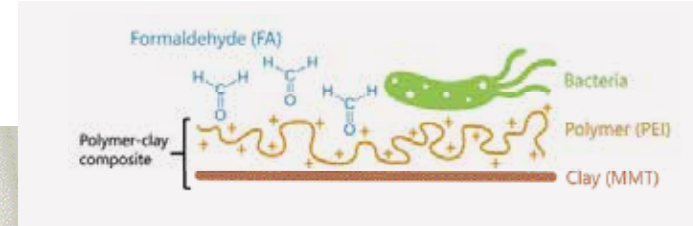
Wastewater purification

Researchers at Technion have developed an innovative technology for the cost-effective removal of formaldehyde from wastewater.

Formaldehyde is used in the production of glue and is common in the wood, paper and textile industries. Since removing formaldehyde from water is very expensive, some companies simply keep the contaminated water in barrels, waiting for the day that a satisfactory solution is discovered. The material developed by the Technion team is based on montmorillonite clay that has been modified using a polymer that changes the overall negative charge to positive. Thanks to this modification, the clay absorbs the formaldehyde and reduces its concentration. Bacteria that break down the substance are pre-attached to the material. After each cycle of formaldehyde decomposition, the material cleans itself for another round.

The research was led by Prof. Adi Radian and Ph.D. student Yael Zvulunov of the Faculty of Civil and Environmental Engineering, in collaboration with Prof. Ayelet Fishman and Dr. Zohar Ben-Barak Zelas of the Faculty of Biotechnology and Food Engineering. The team's findings were recently published in the *Chemical Engineering Journal*.

Prof. Adi Radian



According to Prof. Radian, the development may also be relevant for other uses, such as adsorption and degradation of pesticides that threaten to contaminate groundwater. The study was supported by the Russell Berrie Nanotechnology Institute (RBNI) at Technion and the Israeli Ministry of Science and Technology.

Prof. Adi Radian is holder of the Andre Deloro Career Advancement Chair in Engineering.

GTEP Grand Technion Energy Program

Power of the Future

The Nancy and Stephen Grand Technion Energy Program (GTEP) has been shining a spotlight on sustainability issues at Technion since 2007. A multidisciplinary research and education initiative, GTEP unites experts from around the world and inspires sustainable solutions for the global energy challenge.

One of GTEP's most impressive outcomes is the recent establishment of the start-up H2Pro, which developed an innovative production technology for the wide-scale adoption of sustainable hydrogen fuel (See Page 1). Other GTEP breakthroughs include photoelectrochemical cells that promise renewable, clean production of energy from sunlight; developments in heterogeneous catalysis; alkaline fuel cells and many others.

"The program has had a big impact on campus," asserts GTEP director Prof. Yoed Tsur of Technion's Wolfson Faculty of Chemical Engineering. "Today there are dozens of faculty and students involved in sustainability-related research."

GREEN CAMPUS INITIATIVE

The Technion Sustainable Campus Initiative is thriving, with plans to upgrade environmental awareness at Technion through teaching, research and institutional performance. The initiative is headed by Prof. Daniel Orenstein of the Faculty of Architecture and Town Planning, who is a world expert in ecosystem service assessment and environmental policy in the face of ecological change.

Prof. Orenstein's mission is for Technion to provide an exemplary model for national and global sustainability through its educational and research programs and its institutional behavior. "The university is committed to taking steps. Since last spring, the Green Campus initiative has been reinvigorated, with more funding," he notes.

Courses focusing on sustainability issues are increasingly being offered in all faculties, and efforts are being made to create new classes on these subjects in departments where they are currently lacking. Prof. Tali Tal, head of the informal science and environmental education research group at the Faculty of Education in Science and Technology, is spearheading efforts to prioritize environmental education.

Prof. Daniel Orenstein

Prof. Orenstein also seeks to elevate the exposure of Technion researchers who are involved in scientific research related to the environment and sustainability. "The knowledge is here," he stresses, adding that Technion has relative advantages in a number of relevant fields.

As far as the campus itself is concerned, Prof. Orenstein admits that there is still a long way to go, but he is optimistic. Student initiatives, such as a special course on climate change organized by doctoral student Orr Gallant, are receiving greater attention and encouragement. Moreover, a long-term plan has been formulated with the aim of significantly improving Technion's performance as a green leader. New guidelines will rid the campus of single-use plastics, encourage composting, and favor more efficient energy use and waste flow systems – among other goals.

Disarming the Salmonella Toxin

Faculty of Biology scientists have succeeded in inhibiting the protective mechanism of Salmonella bacteria by using substances originally developed to treat Alzheimer's disease.

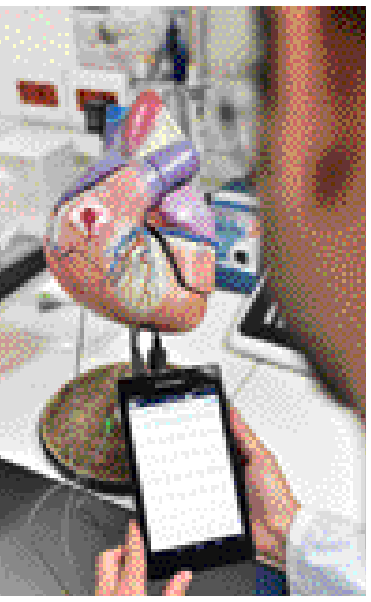
The discovery made by Prof. Meytal Landau, doctoral students Nir Salinas and Nimrod Golan, and the laboratory research team, was published in *PLOS Pathogens*, and is expected to lead to the development of innovative treatments that will reduce the aggressiveness of virulent bacteria, hopefully without inducing resistance.

The researchers were able to inhibit biofilm formation in Salmonella bacteria. Biofilm, a resistant layer of microorganisms that form on and coat various surfaces, constitutes a serious medical and environmental problem because it protects bacteria and enables them to attach to tissues, medical devices, pipes and more.

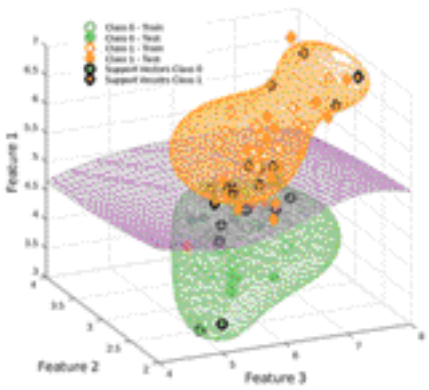
Prof. Meytal Landau *(left)* and doctoral student Nir Salinas

The research is being carried out in collaboration with the Institute for Complex Systems in Jülich and in Düsseldorf, Germany. The Technion Center for Structural Biology (TCSB), the Lorry I. Lokey Interdisciplinary Center for Life Sciences and Engineering, the Electron Microscopy Center, and the Center for Electron Microscopy of Soft Matter in the Russell Berrie Nanotechnology Institute (RBNI) also provided assistance for this project.

AI to Detect Sleep Apnea



An international research team led by Technion has developed an innovative AI-based technology for monitoring obstructive sleep apnea.



The study was led by Prof. Joachim Behar of Technion's Faculty of Biomedical Engineering, and the findings were published in *The Lancet Group's* open-access journal *EClinicalMedicine*.

Obstructive sleep apnea (OSA), which affects more than one in five adults, causes fatigue and sleepiness during the day and can lead to accidents. The syndrome also increases the risk of developing diabetes and cardiovascular disease.

The technology that Prof. Behar and his team developed is based on data from 887 subjects from the general adult population in Sao Paulo, Brazil. Using artificial intelligence, the researchers succeeded in differentiating between OSA sufferers and non-sufferers. The system was able to successfully identify all important clinical cases of medium or severe OSA. Standardized sleep apnea diagnosis questionnaires, by comparison, missed more than 15% of severe cases. "This means that the model we developed is a reliable and effective tool for identifying sleep apnea in large populations. In the future, with the development of a suitable mobile application, the model will make it possible for anyone with a smart watch or bracelet that includes an oximeter to perform an accurate self-examination for OSA," Prof. Behar said.

Prof. Joachim Behar

Nanoparticles to Treat Pediatric Cancer

A new technology that uses ultrasound-responsive nanoparticles to kill a tumor by focused ultrasound has been developed by Prof. Alejandro Sosnik and master's student Vladi Kushnirov-Melnitzer of Technion's Faculty of Materials Science and Engineering.

The nanoparticles are designed so that they enable the encapsulation and targeting of anti-cancer drugs in combined anti-cancer treatments. The researchers verified the micro-structure of the platform using Themis, the advanced electron microscope installed at Technion's Faculty of Materials Science and Engineering. Their research was published in *Advanced Functional Materials*.

The uniqueness of the new nanometric particles lies in the integration of ceramic and polymer components. The researchers discovered that these particles are sensitive to ultrasound – a fact that gives them great significance in destroying cancer. Their clinical goal is the use of this innovative technology for the treatment of a wide variety of malignant tumors, and especially of pediatric ones, through initial targeting of the nanoparticles to the tumor and the localized irradiation of the nanoparticles with ultrasound, which induces the production of highly reactive and cell-toxic compounds in the proximity of cancer cells. In this way, one can minimize the side effects of regular chemotherapy and localize the elimination of the tumor without damaging healthy cells, which represents a long-term disadvantage in the treatment of pediatric tumors.

Prof. Alejandro Sosnik

"This is the first time that titanium oxide nanoparticles have been used successfully to incorporate drugs at the synthesis stage," said Prof. Sosnik. "We hope that the success of our experiments will lead to preclinical trials that will validate its therapeutic efficacy."

The research was initially supported by the European Commission (FP7) and the Russell Berrie Nanotechnology Institute at the Technion (RBNI) and has recently received new funding from the Israel Science Foundation.

AI for Personalized Cancer Treatments

Technion researchers have developed a deep learning-based method for mapping critical receptors on cancer cells.

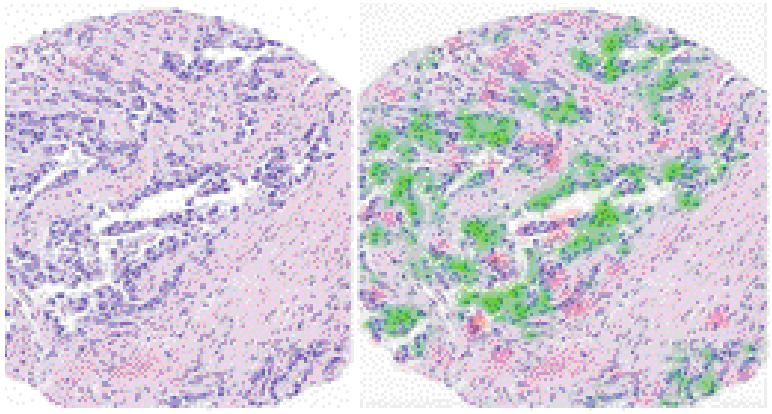
Using digital images of biopsies taken from breast cancer patients, the new technology is expected to significantly improve personalized cancer treatments. Published in the prestigious *JAMA* journal, the research was conducted by Prof. Ron Kimmel and doctoral students Gil Shamai and Ron Slossberg of the Faculty of Computer Science, in collaboration with Dr. Yoav Binenbaum of Ichilov Hospital and Prof. Ziv Gil of Rambam Medical Center.


Doctoral Student Gil Shamai


Doctoral Student Ron Slossberg

"Pathologists we spoke to said it was an impossible task. A human pathologist cannot infer the tumor features from its shape because of the sheer number of variables," Prof. Kimmel and Mr. Shamai explained. "The good news is that artificial intelligence technologies, and especially deep learning, are capable of doing so. The computer, unlike even the most skilled pathologist, can characterize the cancer with a complex analysis of its morphology."

The study examined more than 20,000 scans from 5,356 breast cancer patients. Using the new technology, the researchers were able to map estrogen and progesterone receptors, among other molecular biomarkers, based on cell morphology hematoxylin and eosin-stains of histological image. The study focused on breast cancer, but the researchers make it clear that this is a feasibility study relevant to all cancers.

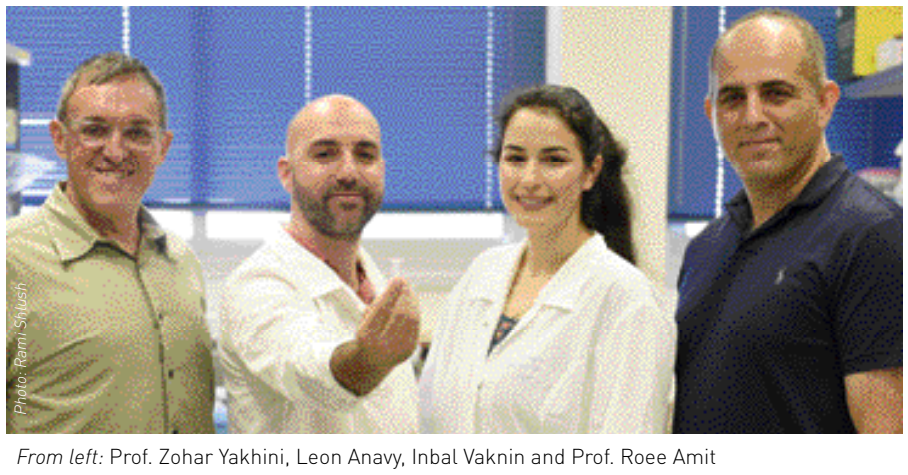

The original scan *(left)* and the areas where information was extracted *(in red and green, right)* using the technology developed at Technion

"We have succeeded in showing that cancer has a unique signature in tissue morphology and that computerized mapping of this morphology can give us tremendously relevant information on tumor characteristics. In the first phase, we believe it will be a tool to help doctors make decisions and will later be developed as a real clinical tool," said Prof. Kimmel.

Prof. Ron Kimmel is the holder of the Montreal Academic Chair.


Prof. Ron Kimmel

All of YouTube on a Teaspoon



From left: Prof. Zohar Yakhini, Leon Anavy, Inbal Vaknin and Prof. Roee Amit

Researchers have demonstrated a significant improvement in the efficiency of storing digital information in DNA.

In a paper published in the journal *Nature Biotechnology*, the group demonstrated storage of information in a density of more than 10 petabytes in each gram of DNA (one petabyte equals one million gigabytes) while significantly improving the writing process. Theoretically, this density makes it possible to store all the information on YouTube in a volume equivalent to a single teaspoon.

The study was led by research student Leon Anavy of the Faculty of Computer Science, under the guidance of Prof. Zohar Yakhini of the Technion Faculty of Computer Science and the Efi Arazi School of Computer Science at IDC Herzliya.

The study was conducted in collaboration with Prof. Roee Amit's Synthetic Biology Laboratory at the Technion Faculty of Biotechnology and Food Engineering.

Prof. Yakhini explains that, "The current synthesis and sequencing processes are inherently redundant, because each molecule is produced in large numbers and is read in multiple copies during sequencing. The method we developed leverages this redundancy to increase the effective number of letters well over the original four letters, making it possible for us to encode and write each unit of information in fewer cycles of synthesis."

"The study included the actual implementation of the new coding technique for storing large-volume information on DNA molecules and reconstructing it for testing the process," says Prof. Amit.

Risks of Probiotics

Scientists from Technion and Boston Children's Hospital have discovered that probiotic consumption may lead to blood infections.


Prof. Roy Kishony

Published in *Nature Medicine*, the study is based on a collaboration between Technion scientists Prof. Roy Kishony and Dr. Idan Yelin and research groups led by Profs. Gregory Priebe and Thomas Sandora from Boston Children's Hospital. Their research revealed that the risk of taking probiotics may outweigh the benefits. By using advanced whole-genome mapping technology, they proved for the first time that, in some cases, infection-causing bacteria originate in the probiotics administered to the patient.


Dr. Idan Yelin

The research is based on data collected over a 5 1/2-year period from 22,174 patients treated at Boston Children's Hospital's Intensive Care Unit. Of the 552 patients who received probiotic capsules as part of their treatment, six were diagnosed with blood infections; among the thousands of patients who did not receive probiotics, none was diagnosed with this type of blood infection.

Using innovative genomic tools, the scientists provided evidence that the source of the blood infection was indeed the probiotic bacteria. The DNA sequences of the bacteria from the infections were fully determined at the Technion Genome Center, along with the DNA of bacteria from the probiotic capsules, and the data revealed that the bacteria in the capsules and in the blood can not be genetically separated. The scientists also found that, in addition to the risk of infection, probiotic consumption may also trigger the growth of bacteria resilient to antibiotics.

Prof. Roy Kishony is the holder of the Henry and Marilyn Taub Chair in Life Sciences.

CS 50 YEARS AHEAD

Technion's Faculty of Computer Science – whose alumni are a driving force behind Israel's high-tech industry – is celebrating 50 years of groundbreaking achievements.

Founded in 1969, Technion's Faculty of Computer Science is ranked among the best in the world. Among its most important breakthroughs is the Lempel-Ziv algorithm, which facilitated a revolution in digital compression technology.

In the 50 years since it was established, the Faculty, housed in the magnificent Taub Family Science and Technology Center, has educated nearly 8,000 students, most of whom now hold key positions in the Israeli high-tech industry. These include Dr. Yoelle Maarek, Vice President of Amazon worldwide; Dr. Eran Eden, co-founder and CEO of MeMed; Karin Eibschitz Segal, CEO of Intel Israel's development center; Dr. Kira Radinsky, co-founder and chairwoman of Diagnostic Robotics; and Oded Cohen, director of the IBM research center, all of whom attended the jubilee festivities.

"We have built an amazing place here during the past 50 years," said Faculty Dean Prof. Dan Geiger. "This Faculty is the backbone of the Israeli high-tech industry and its graduates serve in key positions in the Israeli economy."

In the past four years, there has been a 50% increase in the number of undergraduate degrees in Computer Science and a 90% increase in graduate students in the Faculty. Last June, 369 students received degrees from the Computer Science Faculty – of which 303 were BSc degrees, 53 Master's and 13 PhDs "This year, we were also honored and proud that the Faculty received the Yanai Award for Teaching Excellence," Prof. Geiger added.

"Technion's Computer Science Faculty has a wonderful history," agreed Technion President Prof. Uri Sivan. "We all proudly follow its ascent. I wish the students, faculty and staff a Happy Jubilee. I am sure they will continue to prosper and succeed."

BEE-FREE HONEY

Meeting the demand of a declining bee population, Technion students invent vegan honey, produced without a single bee.

The Technion team at the iGEM competition in Boston

The Technion students recruited the bacterium *Bacillus subtilis*, which can be programmed to produce honey in the lab. The process facilitates control of the properties of the honey, including its taste. The student innovation won the Technion team a gold medal at this year's International Genetically Engineered Machine (iGEM) competition in Boston.

This is the sixth gold medal won by Technion in this prestigious competition in the past seven years. This year, some 300 teams from universities all over the world took part in the competition. In addition to winning a gold medal, the Technion team was ranked in the top five in the category of community contribution, thanks to a Hackathon they organized for outstanding Haifa high-school students on the subject of sustainability.

Student groups from Technion have been participating in the competition since 2012 under the initiative of Prof. Roee Amit, head of the Synthetic Biology Laboratory for the Decipherment of Genomic Codes in the Faculty of Biotechnology and Food Engineering, and Lab Director Dr. Orna Atar. This year's Technion delegation consisted of 12 students from six different faculties.

Participants are required not only to develop a scientific-technological idea but also to present themselves as real business enterprises. As such, over the years, dozens of start-ups have been born through the international competition. "The winnings in the competition are definitely exciting, but equally important is the intellectual property created around the project," says Prof. Amit.

TECHNION INTERNATIONAL 10 YRS

10 Years for Technion International

Technion International opened in August 2009 with 22 students and is now a global knowledge hub with a student body from all over the world.

To date, 2,953 students from 73 countries have been enrolled at Technion International (TI). This year, 42 students completed their studies at TI, receiving degrees in either Civil and Environmental Engineering or Chemical Engineering. More than half are continuing on to a Master's degree at Technion.

The 10th anniversary celebrations took place in August, together with Technion International's graduation ceremony. Guyan Chen from China told the audience about her experience at Technion on behalf of TI's Chemical Engineering graduates.

Then-Senior Executive VP Prof. Adam Shwartz told the students: "You have worked very hard here, but you have gained extensive and solid knowledge that has prepared you for the road ahead in academia and in industry. We live in a very competitive world where diverse skills are required, one of which is working in a multinational, multicultural and multilingual team, and you have acquired that here."