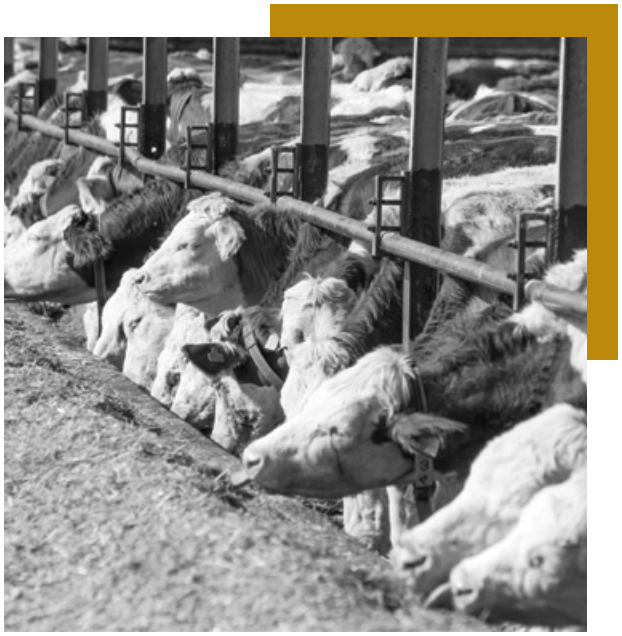
TECHNION
Israel Institute of Technology

# THE TECHNION SUSTAINABLE PROTEIN RESEARCH CENTER (SPRC)

# A Global Food System on the Brink

The world is in the midst of a food crisis as hunger, food insecurity and malnutrition are on the rise. According to the United Nations report *The State of Food and Nutrition in the World,* up to 828 million people across the globe went hungry in 2021. This marks an increase of 150 million people since the start of the COVID-19 pandemic in 2020. The same report notes that 149 million children under the age of 5 had stunted growth and development due to a chronic lack of essential nutrients. Paradoxically, in a 2022 press release, the World Health Organization reported that more than a billion people worldwide are obese: 650 million adults, 340 million adolescents, and 39 million children. In wealthy, high-meat-consuming regions of the world, the prevalence of obesity is exploding amongst children and teens. According to the website of the U.S. Centers for Disease Control and Prevention, during the calendar years 2017–2020, a frightening 12.7% of 2- to 5-year-olds; 20.7% of 6- to 11-year-olds; and 22.2% of 12- to 19-year-olds were categorized as obese.



As the rate of food consumption grows, and particularly the demand for food protein (defined as the protein content within everyday food, and a vital component of human diets), the continued reliance on animals as a food source is increasingly unsustainable and environmentally harmful. The UN predicts Earth's population will increase by another 20% by midcentury, with an even faster rise in meat consumption, according to the World Economic Forum. Seventy percent of all agricultural land, which is 30% of the land surface of the planet, is already devoted to food-protein production according to the UN's Food and Agriculture Organization. Food systems cause 34% of greenhouse gas emissions worldwide, notes a study published in *Nature Food*, with food-protein production systems accounting for half of those emissions. Continued dependence on animal-based protein will further elevate greenhouse gas emissions and drain the planet's land freshwater resources, ultimately leading to a dangerous reduction in biodiversity on a global scale. due to deforestation and mass agriculture. Animal welfare considerations are also gaining wider support, not only among vegans and vegetarians, but among members of the general public who object to animal cruelty. Meanwhile, the expanding use of antibiotics on livestock animals could further exacerbate the problem of antibiotic-resistant bacteria[1]. The UN Ad Hoc Interagency Coordinating Group on Antimicrobial Resistance has projected that antibiotic-resistant bacteria could cause 10 million deaths each year by 2050. A paradigm shift in food-protein production is urgently required.

[1] In 2019, 1.27 million deaths worldwide were the direct result of drug-resistant bacterial infections, killing more people than HIV/AIDS (864,000 deaths) or malaria (643,000 deaths).

**Ensuring sustainable global food security in the future will depend on innovation: Creating new, clean and reliable production systems that allow for the inexpensive, abundant production of healthy and renewable food-protein sources.**

## Transitioning to Sustainable Food-Protein Production

The Technion is leading the change toward sustainable food-protein sources, laying the groundwork for the creation and commercial production of cost-effective meat analogs. Using novel technologies, large quantities of meat can be cultivated from just a few isolated animal cells without killing a single animal. Two startup companies have been based on Technion technologies in the cultured meat area: Aleph Farms (based on the tissue engineering technology developed by Prof. Shulamit Levenberg) and Meatafora (based on the cell-microcarrier technology developed by Prof. Marcelle Machluf, the enzymatic-binding technology developed by Prof. Ayelet Fishman, and fat texturization technology developed by Assoc. Prof. Maya Davidovich-Pinhas). Prof. Eyal Zussman is developing electrospun plant protein nanofibers as scaffolds for cultured meat product development. Prof. Yoav Livney, collaborating with researchers at other Israeli institutions, has developed a strategy to efficiently extract edible algal protein concentrate from protein-rich seaweeds. Meanwhile, Prof. Ayelet Fishman has shown how to transfer a specific gene (for the potato protein Patatin) into yeast, so that when yeast ferments, it releases the protein (rPatatin). This enables the inexpensive, large-scale production of this protein for animal-alternative food products[2]. At the same time, Assoc. Prof. Avi Shpigelman has developed a fermented (cow-free) yogurt alternative from patatin by combining novel processing technologies. The Technion's excellence in this area of research has led to collaborations with food industry giants (e.g., Danone and PepsiCo), as well as many leading startups focused on sustainable protein production. Moreover, as a founding partner of EIT Food (an organization established by the European Institute for Innovation & Technology to drive food innovation across Europe), the Technion is in close contact with other leading universities and food companies across the globe.

The Technion is now set to augment its innovation in the field of sustainable food-protein production by establishing a world-class, first-of-its-kind sustainable protein research center covering all research pillars in the field.

[2] Patatin protein contains high nutritional value and functional properties that add richness and texture to food; before this innovation, culling Patatin from potatoes typically involved an expensive extraction and purification process.

# A Hub for Sustainable Protein Research at the Technion

The **Technion Sustainable Protein Research Center** will harness bold and exciting initiatives from many of the Technion's 18 academic faculties and will be supported by and coordinated with adjacent Technion initiatives, such as the Human Health Initiative and the Sustainability Initiative. Fusing the brilliant insights of protein experts, nutrition specialists, medical professionals, data scientists, mechanical engineers, chemical engineers, and others, the new multidisciplinary Center will tackle the most critical research challenges, and forge a new path to reliable, sustainable food-protein production. The Center will contribute to advancing solutions that address the United Nations' Sustainable Development Goals, including goals 2 (zero hunger), 3 (good health and well-being), 6 (clean water and sanitation), 9 (industry, innovation and infrastructure), 11 (sustainable cities and communities), 12 (responsible consumption and production), 13 (climate action), 14 (life below water), 15 (life on land), and 17 (partnerships to achieve the goal). The Center will open new doors to the development of protein substitutes for meat, fish, eggs, milk, and other animal-based products, offering significant new potential for improving the sustainability of Earth's natural resources while providing greater nutritional health for people for generations to come.

The new Center will partner with the Good Food Institute (GFI), an international non-profit organization with a strong Israeli branch working to accelerate sustainable protein innovation. The GFI has been highly supportive thus far in the initiation stages of this endeavor. Together, the Technion and the GFI will develop the fundamental knowledge, tools, and expertise to promote plant-based, cell culture-based, and fermentation-based food-protein alternatives.

**The Center will work on the following technological advances (among others):**

1. **Plant-based solutions:** Breeding and engineering for higher plant-protein yields and functionality; better protein fractionation and functionalization processes, and improved plant fat profiles; novel methods for texturizing and structuring plant-based proteins

2. **Cell culture-based solutions:** Bioreactors capable of supporting high-density, large-volume cell cultures; scaffolding biomaterials that support cell adherence and differentiation; cell culture media optimization and recycling methods to reduce costs

3. **Fermentation-based solutions:** Increased concentrations and yields for fermentation-produced ingredients via strain engineering; screening and adaptation of novel strains as commercial candidates; feedstock optimization for exploiting existing biomass streams

The Center will introduce state-of-the-art technologies and train the next generation of industry researchers and startup innovators. At the same time, the Center will construct an evolving inventory of models and insights into the fundamentals of sustainable-protein innovation. The Center's research will promote multidisciplinary collaborations. With its strategic alliance with the Good Food Institute and its partnerships within academia and industry in Israel and abroad, the Center will help build a prolific research ecosystem. New Technion faculty will be recruited from among the best and brightest minds, universities, and research centers worldwide to advance relevant areas of expertise.

In essence, the Technion Sustainable Protein Research Center will function as an international hub for front-line sustainable-protein research and teaching, paving the way for the commercialization of futuristic, disruptive protein products in a transformative, entrepreneurial environment. These activities will strengthen the Israeli economy and its global leadership in this burgeoning field, and promote global sustainability, food security, and human health for generations to come.

A large part of the Center's research will take place in the new Carasso FoodTech Innovation Center. Currently under construction, this new facility will extend over some 2,800 m2 (~30,140 ft2) and be located adjacent to the Stein Building, home of the Faculty of Biotechnology and Food Engineering. The two-story building will feature a Semi-Industrial R&D Production Facility, a Laboratory for Fermentation Technologies, an Educational R&D Kitchen, a Cultivated Meat R&D Facility, an Analytical Lab, and three research labs for new faculty members.

## Equipping the Center

The capabilities of the Sustainable Protein Research Center are directly linked to the quality of the equipment that is available to researchers.

The study of sustainable protein requires dedicated equipment for protein formation, extraction, purification, and analysis (including functional and nutritional property characterization (e.g., protein quantity, amino acid composition, foaming-emulsifying-gelling properties, and digestibility), as well as pilot-scale units to enable the initial scale-up of the processes, toward eventual industrial application.

The protein formation stage requirements include media preparation units and bioreactors for animal cell cultures, as well as fermenters for microbial proliferation, each at several size scales. The protein extraction and purification instruments that are required include centrifuges, membrane filtration units, filter press, and drying equipment. The complementary food processing units required (both for the extraction and for final product formation) include a versatile pilot-scale heat exchanger, pilot scale processing tanks, pumps, high shear cooker, pilot-scale tween-screw extruders for high and low moisture products, pilot-scale 3D food printer, electrospinning machine, and experimental kitchen equipment. For protein analysis, researchers will require a fast protein analyzer, high-pressure liquid chromatography (preparative and analytical), and a simulated digestion unit.

Architect's rendering of the Semi-Industrial R&D Production Facility in the future Carasso FoodTech Innovation Center

Prof. Avi Shpigelman and Lab Manager Dr. Zoya Okun
in the Laboratory for Novel Food and Bioprocessing

## Project Leadership

The Technion Sustainable Protein Research Center will be headed by Prof. Yoav Livney of the Faculty of Biotechnology and Food Engineering. The Center's senior team will also include Assoc. Prof. Avi Shpigelman (Faculty of Biotechnology and Food Engineering) and David Shem Tov (Head of Innovation and Applied Research at the Technion Research & Development Foundation). The team has already started assembling a consulting board of experts from various Technion academic departments, and an external advisory board of high-ranking industry and academy representatives from Israel and abroad.

**The Technion Sustainable Protein Research Center's core tasks will include highlighting basic research, promoting applied research, and assisting in the commercialization of technologies emanating from its activities. Additionally, the Center will implement a comprehensive educational agenda designed to train tomorrow's innovators and entrepreneurs via new graduate-level and postdoctoral study programs.**

**In support of these tasks, foundational activities during the first five-year period (January 2023 to December 2027) will focus on the following:**

Applying for philanthropic support, together with the Good Food Institute, for seed money and equipment, to enable competitive grant applications to external funding agencies

Acquiring governmental support for the Center with the help of the Good Food Institute

Acquiring laboratory and pilot scale equipment

Coordinating the purchase and maintenance of equipment and facilities at the different faculties

Actively guiding the recruitment of new researchers to various faculties on campus, and assisting in obtaining their startup funds

Applying for the European Union's "COFUND"program, which will bring the most brilliant European postdocs to the Technion and establish an entrepreneurial postdoc program

Organizing annual conferences to promote discussion and multidisciplinary collaboration

Promoting relations with industry by providing R&D and scale-up support to both startups and larger companies, both in contract research and in research services. It will also disseminate knowledge by offering training to industry personnel (short courses and seminar days).

Engaging in social media outreach efforts to increase public awareness for the required transition from animal-based nutrition to more sustainable alternatives

Forming "live labs" on and off campus to test new developments on consumers under scientific conditions and on both the clinical and behavioral levels

# **Measurement and Evaluation:** Performance Targets for the First Five Years

**Within the initial five-year period, the Center will aim to achieve the following performance targets:**

- Recruiting 2–3 new faculty members in different faculties and supporting their labs with equipment, students, and research assistants
- Supporting a minimum of 10 postdocs (we aim to obtain complementary funding from the European Union which, if we are successful, will increase this number to 35)
- Providing partial support for more than 35 graduate students
- Publishing at least 50 publications in reputable journals
- Submitting more than 10 patents

Prof. Yoav Livney and PhD student Yarden Abuhassira-Cohen in the Lab of Biopolymers for Food and Health

Lab-grown meat


The Taste of the Future Conference held at the Technion, from left to right: David Shem Tov, Technion Research Authority; Dr. Michal Halpert, GFI; Dr. Liz Sepecht, GFI; Prof. Shulamit Levenberg; Nir Goldstein, GFI; Ella Waldman, GFI; Conference Chair Prof. Yoav Livney; Prof. Eyal Zussman; Dr. Neta Lavon, Aleph Farms; Prof. Uri Lesmes; Doron Maor, Tnuva; Anya Eldan, Nury Ventures; Prof. Avi Shpigelman; Roni Zidon-Eyal, Imagindairy; Prof. Maya Davidovitch-Pinhas; Technion President Prof. Uri Sivan.

## Funding Opportunities

The total budget to establish and operate the Technion Sustainable Protein Research Center over a five-year period is $19,064,000.

Project components of various sizes are available for funding.

Your generous contribution will enable the Technion to join a worldwide effort and work toward a more sustainable global food system.

Donor recognition will be in accordance with Technion standards.

# Project Budget (Five Years)

| Item | Total (CAD) |
|---|---|
| **Human Resources** | |
| — Center Director | 305,600 |
| — Faculty Recruitment | 6,416,000 |
| — Postdoctoral Research Fellowships | 1,145,700 |
| — Graduate Fellowship Discretionary Fund | 954,800 |
| — Advisory Board Recruitment and Meetings | 76,400 |
| — Technical Personnel | 1,100,000 |
| **Total Human Resources** | **9,998,500** |
| **Physical Infrastructure** | |
| — Construction Costs | 9,165,600 |
| — Equipment Purchase | 4,888,400 |
| — Equipment Maintenance | 46,000 |
| **Total Physical Infrastructure** | **14,100,000** |
| **Research Promotion** | |
| — Collaborative Seed Grants | 2,291,400 |
| — Research Conferences and Seminars | 152,800 |
| **Total Research Promotion** | **2,444,200** |
| **General Infrastructure Costs** | **395,700** |
| **Total Project Cost** | **26,938,400** |

# THANK YOU

3D-printed steak made from plant-based materials

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