



The next big thing for food: cellular agriculture –

How cultured plant cells will
transform the current food system

beyond the obvious

About this handbook

The world is hungry for clean, healthy and nutritious food. At the same time, people are waking up to the consequences of our way of living and the harmful effects of food production on the environment.

To build a future with enough healthy food for everyone without overwhelming the planet, we must transform our current food system.

This to-the-point handbook explains how cellular agriculture can help build that future. Cellular agriculture, a sustainable option for food production, has the potential to disrupt the current food system and to provide an alternative to unsustainable and unethical production methods. As well as offering a

brand-new way of producing food, cellular agriculture has already begun to generate new business opportunities.

Who is the book for?

We created this handbook for everyone with an appetite for innovation and interest in shaping the future of food.

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Why do we need cellular agriculture?

Food is one of our basic needs and great joys. But the way we are currently producing food is hurting both us and the environment. Here are some of the key reasons why a radical transformation of the current food system is needed.

Cellular agriculture in a nutshell

Cellular agriculture refers to the production of agricultural commodities using cells cultivated in fermenters instead of relying on fields and farmed animals.

Plant cell cultures can be established of any plant species. With cellular agriculture, plants can also be grown anywhere: in bustling cities, remote deserts – even in outer space.

Cells instead of plants



*Uniform cells containing all essentials
Avoiding waste from unproductive stems, stalks, leaves etc.*

Feeding the world well

While we need food to survive, just any food will not do. We need food that is safe, healthy and nutritious instead of food that is just calorie-dense and cheap. Today, more than 820 million people¹ are inadequately nourished while many more get by with low-quality diets. A global shift towards healthy diets will require substantial dietary changes as well as significant increases in the consumption of plant-based foods.

But even good foods that offer nutritional benefits can be bad if we zoom in on the ethical concerns. From coffee to avocado to cacao, many food items that are considered healthy are fuelling deforestation as well as causing water shortage and human right issues, among other things.

There's an increasing need for food that is both healthy and ethically produced – food that can be consumed guilt-free.

Responding to environmental challenges

Pollution, erosion, insect extinction. These are just a few examples of the effects of our current way of producing food. They are also strong drivers for finding more sustainable solutions that minimize things like resource input, greenhouse gas emissions and fertilizer run-off.

Meeting the UN Sustainable Development Goals

In 2015, the United Nations issued a universal call to action to end poverty, to protect the

planet, and to ensure that by 2030, all people would enjoy peace and prosperity.²

To achieve the Sustainable Development Goals (SDGs), new business models and technological innovations are urgently needed.

Moving from animal proteins to plant-based alternatives

In recent years, the demand for alternatives to regular meat has surged. People crave options that are high in protein as well as cruelty-free.

The increasing interest in plant-based alternatives opens a world of opportunities for businesses in the future.



The future of food is in cultured cells

Food production based on microbial and cellular systems is nothing new. In fact, many companies have already set up operations, producing cultured meat and other alternative protein products. Let us have a look at some success stories that have made waves in the market and paved the way for cellular agriculture – the next big leap in food production.

Example 1: From lab to plate: Lab-grown chicken on a restaurant menu in Singapore

In 2020, the California-based food startup Eat Just introduced to the market the world's first chicken created in a lab. Eat Just's product is made from real meat grown from cells derived from chickens. Eat Just's chicken bites have passed a safety review by the Singapore Food Agency and are now available for consumers in a restaurant in Singapore. ³

Example 2: Eggs without chicken at a competitive cost

VTT has successfully developed a safe, environmentally sustainable and cost-effective method to mass-produce high value proteins – such as egg white – without using animals. The process uses a fungus to produce the proteins from nothing but water, glucose and minerals.

In 2020, VTT's technology won the first prize in the Impact Expected category of the EARTO Innovation Awards 2020. The technology is commercially scalable and will soon be available for consumers. ⁴

Example 3: Food out of thin air

Solar Foods, a food tech company founded in 2017 as a spinoff from a VTT Technical Research Centre of Finland and Lappeenranta University of Technology research programme, has created a ground-breaking way to produce a natural protein using only electricity and air. The process resembles that of brewing beer, but instead of yeast and sugar, it uses water from the air for the microorganisms to live in and feeds them CO₂ and some nutrients. The end-result is a protein-rich powder called Solein[®]. This natural protein can be used as an ingredient in any food, thus unlocking a world of opportunities. ⁵

Technology is moving fast and creating new opportunities every day. In 2013, when the first lab-grown meat burger was created, there were only a handful of companies working on the novel idea to create lab-grown alternatives for conventionally produced food items. Today, hundreds of companies and startups across the globe are racing to introduce new commercial products to the market.

Did you know?

Lord Rank, the founder of Quorn[®], recognized already in the 1960s that conventional farming couldn't keep up with the food demand and began to look for new, sustainable sources of protein.

After screening over 3,000 soil samples from around the world, Rank discovered *Fusarium venenatum*, a microorganism in the fungi family. The microorganism converts carbohydrates into protein and produces Quorn's unique mycoprotein.

Today, millions of people enjoy a huge range of Quorn meals and by doing so, help the planet. ⁶



4 key advantages of cellular agriculture

First came the microbial biomass i.e. single cell protein products, closely followed by animal protein products. Now, it's time for plant cell cultures to take centre stage and open the door to the next agricultural revolution. Here are some key advantages plant cell cultures have to offer:

- 1. Local.** Plant cell cultures can be grown anywhere, any time. This gives farmers complete seasonal and geographical independence: harvests in the dead of winter, fruits normally found in the tropics now grown within the walls of cities and other urban areas.
- 2. Safe.** As cell cultures are grown in fully controlled, sterile conditions, there's no need to use pesticides or any other forms of harmful chemicals. Thus, the risk of health hazards and losing crops to bugs can be eliminated.
What is more, strict adherence to safety testing is required from all lab-grown products. This ensures that all food products entering the market meet the regulatory requirements and that their quality is assured.

3. Sustainable. Growing plant cells in bioreactors instead of cultivating plants in fields reduces land use and greenhouse gases. Growing food locally also requires less transportation, thus reducing air pollution.

With cellular agriculture, underutilised side streams also become a thing of the past: things like stalks, seeds and peels are simply not produced.

4. Ethical. What do we really know about the production processes and value chains that bring food from farms to our plates? Are the farmers paid fair wages? Are the raw materials grown sustainably? What is the impact on the planet? Cellular agriculture processes are fully transparent and traceable to ensure there's no exploitation of labour or the environment involved.

What does the future hold?

For cellular agriculture, a world of opportunity lies ahead.

Cell-based plant ingredients can be added to already existing products, or completely new food products can be created. The biomass is very nutritious and contains a high protein content with a balanced amino acid profile, dietary fibers and beneficial lipids among other health-promoting components. What is more, the material itself is extremely flexible: it can be molded in any way, shape or form.

The key to future success lies in finding the sweet spot where science and business come together.





How to get started with cellular agriculture

- 1 It all starts with an idea:** wanting to break free from price fluctuations by producing your own raw materials. Or making the move towards cleaner, safer, more sustainable food. Or going from horizontal expansion to vertical expansion and thus reducing dependency on land.

- 2** To transform your idea into reality, you must get **access to the right technology and expertise**. What you need is a plant cell lab, but even more importantly, you'll need experienced specialists with in-depth knowledge of different plants and species.
- 3** Once you've found the right people and the right technology, it's time to **establish a cell culture**. To save time, you can also make use of already existing culture collections. Available cell lines can typically be licensed from the manufacturer.
- 4** Next, it's time to **grow the cells**. For maximum cell growth, the conditions in the bioreactors must be optimal in terms of parameters such as mixing speed, aeration, pH and nutrients. Then, according to the product use, you will want to further process the plant cells, for example dry or shape them. You must also conduct safety and quality assessments, sensory evaluation and chemical analysis to ensure your product's success.

Did you know?

It's not finders keepers when it comes to plants and other wildlife.

In fact, The Nagoya Protocol on Access and Benefit Sharing sets regulations on the utilisation of genetic resources. Simply put, if you want to get your hands on avocados, for example, you can't just go and take them – you are going to need access rights.





VTT CellularFood – Ramp up your cellular agriculture strategy

VTT CellularFood is a step-by-step program that helps you develop your novel food products. The process is designed to help you assess risks, navigate costs and make informed decisions based on pilot findings. We have divided the program into two streams:

- **STREAM 1** helps you identify the potential that cellular agriculture offers your business.
- **STREAM 2** assists you in developing your own product. Think everything from analysis to infrastructure and piloting.

Ready to transform the future of food? Get in touch!

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Learn more

VTT CellularFood:
[Novel food solutions and sustainable future of food production](#)



Sources:

- ¹ [Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems](#)
- ² [The UN](#)
- ³ [This multibillion-dollar company is selling lab-grown chicken in a world-first](#)
- ⁴ [VTT’s technology for the production of egg white protein without chickens awarded by EARTO](#)
- ⁵ [Solar Foods homepage](#)
- ⁶ [Quorn® homepage](#)



VTT is a multidisciplinary contract research and innovation partner for forerunners in the industry. VTT helps in creating customized future food solutions, setting up novel food production as well as piloting and upscaling. The cornerstone of our innovation services is based on biotechnology and bioprocessing technologies that enable the renewal of food processes.

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