



Memphis Meat's \$1,000 lab-grown meatball | COURTESY OF MEMPHIS MEAT

FOOD & DRINK

## Taste test: Does the future of meat lie in a lab?

With farmed animals expected to drain resources worldwide, a handful of groups are looking at the benefits of meat that is grown in a petri dish

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Does the future of meat lie in a lab? Biochemist Yuki Hanyu's vision for the future includes a supermarket that has plenty of meat, none of which has come from a farm. Instead, it has all been grown in a laboratory.

Hanyu is the founder of Tokyo-based startup Shojinmeat Project, a team of volunteers who are conducting research on "cultured meat."

Cultured meat — also called synthetic meat, cell-cultured meat, clean meat and lab-grown meat — refers to meat that is grown from animal cells through a scientific process conducted in a lab.

Hanyu hopes Japan will see cultured meat hitting supermarket shelves by 2030. By that time, he says, consumers can expect the taste of this scientifically grown meat to match, or even exceed, that of animal flesh consumed today. What's more, he adds, cultured meat should be relatively

competitive in terms of its retail price.

Shojinmeat Project is one of a handful of groups around the world that are conducting research on cultured meat.

### Historic first: clean poultry tasting

Some believe it won't take long before farms begin to be replaced by laboratories. U.S. startup Memphis Meats and Dutch team Mosa Meat both forecast that cultured meat will be available to consumers in around five years' time.

In spite of the optimism, however, there are still a number of hurdles to overcome. The overall process is currently expensive and there is a distinct lack of an established body of experts in the field.

Twenty-nine-year-old Erin Kim, communications director at the New Harvest research institute in New York, says the lack of funding for open research on cultured meat is a "major roadblock" for the produce entering the market.

### Leading research role

Shojinmeat Project is the only entity in East Asia that is conducting research on cultured meat.

Hanyu, 32, first started talking about the idea in 2004. "My first experiment was in the bathroom of my house," he says.

Hanyu met his existing project partner, Ikko Kawashima, in a discussion space called Lab+Cafe in Tokyo's Hongo district. They launched Shojinmeat Project in 2014, using Hanyu's background in organic and biological chemistry and his partner's experience in organs and cell culture to begin their first forays into growing meat from animal cells.

Today, around 30 volunteers work in the project's shared laboratory space in Tokyo's Iidabashi district. The team includes writers, designers and business experts, as well as specialists in scientific research across a variety of fields. It is currently raising funds to cover the cost of experiments by selling graphic designs of scientific phenomenon and a fanzine-style publication.



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Shojinmeat Project founder Yuki Hanyu | ROCHELLE KIRKHAM

Shojinmeat Project claims to be at the forefront of research in cultured meat in Asia, but Hanyu qualifies this by adding that you can count the number of groups working on this technology worldwide on one hand. Memphis Meats is a Californian start-up similar to Shojinmeat Project. Mosa Meat, founded by a university professor in the Netherlands, made headlines in 2013 when it created a lab-grown burger. SuperMeat is a cultured meat company in Tel Aviv, Israel, while Washington-based nonprofit The Good Food Institute promotes clean meat grown from both plant and animal cells.

Twenty-four-year-old Emily Byrd, a senior communications specialist at The Good Food Institute, says cultured meat will fundamentally change the meat production industry.

“Seeing meat as a protein supply rather than a dead animal supply is a fundamental shift in the market,” Byrd says.

In Tokyo, bio-hackers at Shojinmeat Project say they are taking an alternative approach to others in the field. Hanyu says the team is keeping their operations small in scale, producing around 1 gram of cultured meat at a time. It aims to reduce the cost of the expensive scientific process before scaling up production in order to ensure financial viability into the future. Hanyu says it currently costs around \$260,000 (almost ¥28.8 million) to create a 200-gram burger made of cultured meat.



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Shojinmeat Project produces 1 gram of meat at a time. | COURTESY OF SHOJINMEAT PROJECT

“We are bringing down the cost,” Hanyu says. “And the price varies depending on what animal cells we are working with.”

Hanyu says that Shojinmeat Project has brought the costs for its experiments down to around \$20 (¥2,200) for easy cells per 100 grams and somewhere around \$2,000 (¥220,000) for more difficult ones. The team is currently trying to grow chicken from chicken cells.

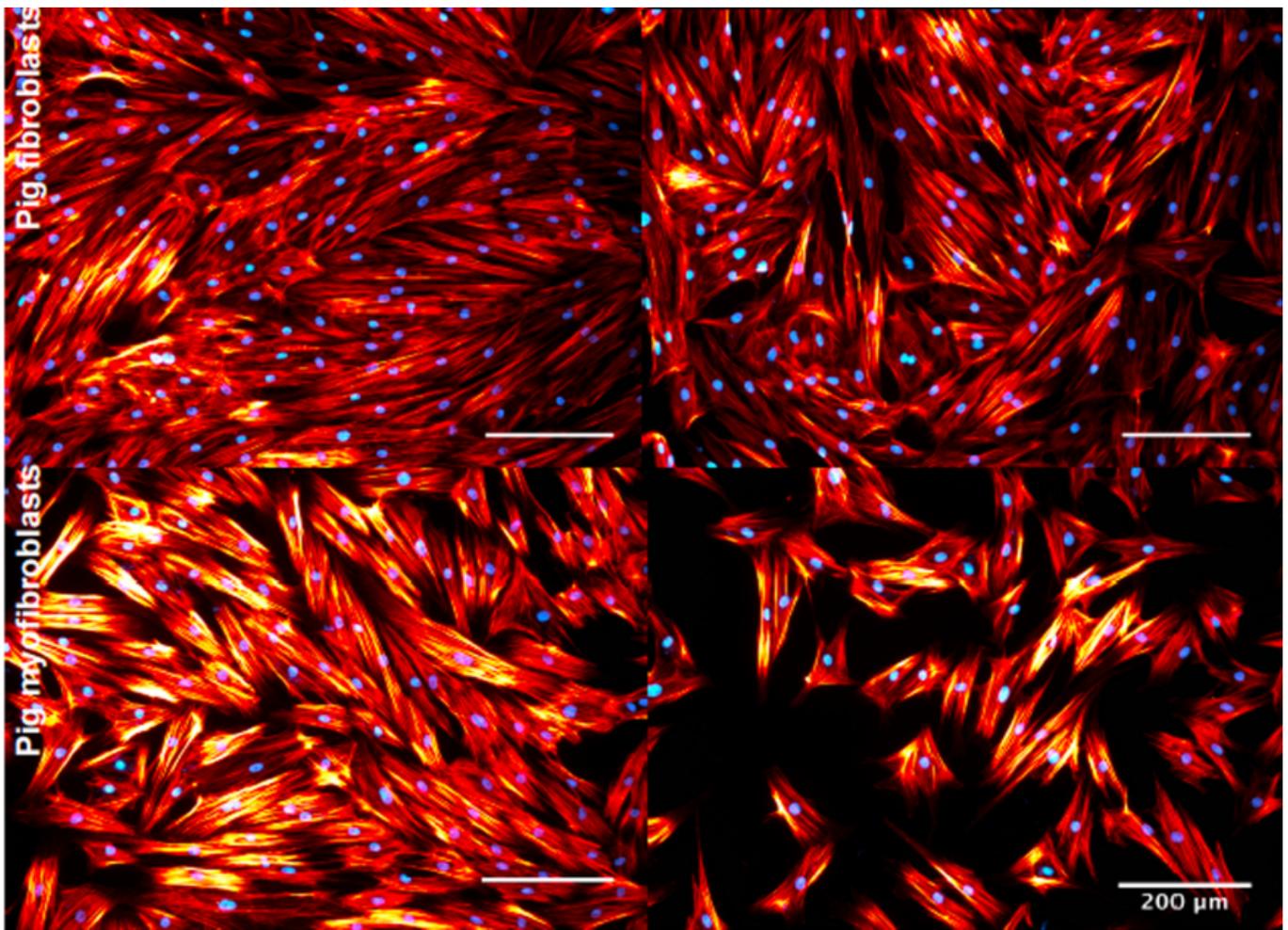
## Unlocking the process

The scientific process Shojinmeat Project uses to grow cultured meat can be broken down into three steps.

First, muscle cells from an animal are placed on a petri dish. At present, the cells must come from a freshly slaughtered animal, although scientific advancements are being made toward “starter cell culture” (scientifically reproduced cells instead of cells that have been extracted from a dead animal).

The cells are then placed in a controlled environment such as a bioreactor with a “culture medium,” which is typically a liquid or gelatinous substance containing nutrients that supports the growth of cells.

Finally, the product grown in the bioreactor from the original animal cells is processed into something that looks like meat.



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Pork cells cultured by New Harvest research fellow Jess Krieger at Kent State University. | COURTESY OF NEW HARVEST

Hanyu says it can take 14 to 20 days for meat to grow from a microscopic scale to something visible. However, he says time would not be a problem if a large processing operation was available.

“If you have got 100 tons of cultured meat, the next day you will have another 100 tons because it multiplies,” he says.

If the scale of cultured meat production is increased, the growth process will be faster each cycle, he says.

For many, the taste of cultured meat is the first question that comes to mind: Will it ever match the taste of “real” animal meat? Hanyu has cooked and sampled meat produced in Shojinmeat Project experiments. “It’s like KFC,” he says when asked to describe the taste of its lab-grown chicken.

Byrd says the goal is to create an exact replacement for meat that will taste the same as animal products available now.

“There is even an opportunity to create even better tasting meat,” Byrd says, adding that scientists could have the ability to customize fat content, for example.

Recent statistics have sparked concern that the world can’t continue to keep up with demand for meat in the future. Human meat consumption has doubled over the past century and annual meat production will have to increase by more than 200 million tons to reach 470 million tons by 2050 to meet expected demand, according to a U.N. Food and Agriculture Organization report in 2012 titled “How to Feed the World in 2050.”

Such statistics have prompted observers to express concern over the security of meat supply in Japan, considering around half of the meat consumed domestically is imported. As a result, companies around the world are seeking alternatives to meat. Some plant-based meat products have already hit supermarket shelves. The Good Food Institute is one U.S.-based team that focuses on supporting plant-based alternatives to animal products in addition to meat grown from animal cells.

Byrd says plant-based meats are selling out in some U.S. supermarkets, where cultured products such as Impossible Foods' groundbreaking Impossible Burger are placed on the shelves beside conventional meat. "People on all sorts of diets have become interested in plant-based meat," she says. "People are lining up around the block for the Impossible Burger like it is the next iPhone."

## **Cutting costs**

But for now, at least, the process remains expensive. Hanyu says the culture medium and the hardware used in the process — namely, the bioreactor — are primarily to blame for the high costs. He says Shojinmeat Project is currently looking at alternatives to reduce the cost of the culture medium. The team has successfully experimented with changing components by replacing one ingredient with Gatorade.

One ingredient of culture medium is animal serum (for example, fetal bovine serum). Not only is it expensive, but Hanyu says he does not want to use an ingredient that involves killing an animal.

In addition to reducing the cost of culture medium, Shojinmeat Project is working to cut the cost of the hardware before scaling up production.

However, Hanyu says it is not only trying to reduce costs. The team is also seeking to establish a recognized field of cultured meat experts. "Because the field (of cellular agriculture) is not recognized, there are no experts," he says. "How would a government fund that kind of field?"

Shojinmeat Project is lobbying for the creation of a college course in cellular agriculture to allow students to start getting degrees in the field. The team has held discussions with the Tokyo University of Agriculture about the creation of such a course.

"Once cellular agriculture is recognized as a discipline, then the government can fund it," Hanyu says, adding that this would ultimately create a field of experts on cellular agriculture who can speak authoritatively on the subject.

Byrd says it is difficult to scale up production of cultured meat because only small start-ups are currently working in the field. "The industry is moving extremely quickly, but really the biggest barrier is funding," she says.

However, Byrd says the future looks promising, with large companies such as Tyson Foods investing in cultured meat. Tyson Foods, the largest U.S. meat company in terms of sales, took a 5 percent stake in plant-based meat start-up Beyond Meat in 2016. The investment followed news of funding from business titans such as Bill Gates and Richard Branson in San Francisco-based Memphis Meats.



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U.S. nonprofit New Harvest supports research into cultured meat. | COURTESY OF NEW HARVEST

Shojinmeat Project hasn't received any external funding, but Hanyu says it doesn't want to hasten large-scale production before reducing costs. It forecasts that cultured meat will be available to the general consumer in around 10 years, a longer timeline than the five-year goal of cultured meat leaders Memphis Meats and Mosa Meats.

In the meantime, Shojinmeat Meat is also working to advance "designer meat" and create a machine that allows consumers to grow their own cultured meat at home. Hanyu says designer meat may be accepted by consumers sooner than cultured meat. Designer meat involves creating a food that has never existed, meaning that cells don't need to be extracted from an animal.

"When offering a totally new food that has never existed, like beef and pork mixed up on a cellular level, it will probably taste different. It's a new concept," he says. "If you're imitating real meat, you're working toward a goal of real meat. But when it comes to designer meat, it could be anything. Any one of hundreds of options could become a hit."

Hanyu says beef combined with fish fat for added health benefits is an example of a designer meat. "It could even have a higher (nutritional) value than real meat," he says. "Whether consumers like the taste or not, let's see."

Many scientists in the field say cultured meat will be beneficial for general public health. The meat is produced in a sterile environment, so it can be guaranteed as being free from dangerous bacteria.

Byrd says cultured meat is fundamentally cleaner from a sanitation perspective.

"With clean meat, you are avoiding the factory farm and slaughterhouse entirely," she says. "From a food-safety point of view, this is a much-improved product in terms of public health. And on a basic nutrition level, this is a one-to-one replacement for animal meat."

New Harvest's Kim says it is important to remember that health predictions are speculative. "There is buzz about it potentially being healthier, but I would be careful about making that claim because there could be a downside we just don't know about yet," Kim says.

Kim says further research into the nutritional impacts of cultured meat will likely begin when the process advances and a product for consumers is developed.

Environmental experts argue that producing enough meat through traditional farming methods to satisfy demand in the future will ruin the planet.

Mehran Rezaei Rashti, an environmental science expert from Griffith University, says grazing livestock produces methane, which has an impact on climate change. "Methane emission is the one that everyone knows about. But we have other problems regarding nitric oxide emissions," Rashti says. "If grazing land is close to an aquatic system, there will be a lot of runoff of nitrate and ammonium from cattle urine that can affect aquatic systems, underground waters or even rivers."

Meat and dairy products account for 70 percent of global water consumption, 38 percent of land use and 19 percent of the world's greenhouse gas emissions, according to the 2012 U.N. Food and Agriculture Department report. "While agriculture will be forced to compete for land and water with sprawling urban settlements, it will also be required to serve on other major fronts: adapting to and contributing to the mitigation of climate change, helping preserve natural habitats and maintaining biodiversity," the report says. "To respond to those demands, farmers will need new technologies to produce more from less land, with fewer hands."

Hanyu says the development of cultured meat will reduce demand on valuable resources such as land and water. Cultured meat production plants in the future will require electricity and water, but Hanyu says it will be almost 40 times less resource-intensive than current meat production.



<https://www.japantimes.co.jp/wp-content/uploads/2017/09/p10-kirkham-meat-c-20170917.jpg>

Memphis Meat's chicken fillet | COURTESY OF MEMPHIS MEAT

## Uncharted territory

Kim says the future of cultured meat is uncertain and there is a possibility that it may never reach the general public.

“Over time there has been a realization of how much we don’t know about cultured meat,” she says. “If, with further research, it is discovered that it could be bad for human health, it could kill the industry before it even takes off. If cultured meat has some kind of a risk, it is going to fail. I don’t think any reasonable consumer is going to take that risk.”

Hanyu says discussions surrounding the regulation of cultured meat in Japan have only just begun. Shojinmeat Project is in the process of explaining what cultured meat is to the Agriculture, Forestry and Fisheries Ministry, which is considered a potential regulating body.

Kim and Byrd say it is likely the Food and Drug Administration will be responsible for regulating cultured meat in the United States. “At the moment we are not seeing problems with regulation,” Byrd says. “It seems like cultured meat will fit previous regulatory models.”

Kim says there is nothing physically to regulate yet, as there is no cultured meat product on the market.

Hanyu, a self-confessed science-fiction fan, envisions growing cultured meat on a large scale in high-rise farms and dreams as far into the future as producing lab-grown meat on Mars.

However, Kim remains skeptical that cultured meat will replace traditional farmed meat entirely. “I hope it will replace a lot of the production but I don’t realistically see it completely disrupting the way meat is produced right now. I think it will be more like a supplement,” Kim says. “I am a foodie — a meat eater, but a reluctant meat eater. People like me are the target market because we are the people who are aware. We go around talking about the environmental impacts of our love of meat but we make that irrational choice of consuming it.”

To fast-track cultured meat’s entry into the consumer market, Kim calls on meat companies to add cultured meat production to their portfolios. “People say it is going to look like a brewery, and there are even more far-fetched visions of being able to produce cultured meat at home or even on a neighborhood scale,” she says. “But those are pretty far off into the future and there is an incredible amount of work that has to be done and discoveries that need to be made before that comes even into the realm of possibility.”



## Humble beginnings

The science behind the technology used to produce lab-grown meat is hardly new. Indeed, Winston Churchill wrote an essay for Strand Magazine as far back as 1931, predicting a future in which scientists produce lab-grown meat by exploiting microbes, just as bakers use yeast to make bread. Other notable dates are as follows:

**2000:** The NSR-Touro Applied BioScience Research Consortium produces edible fish fillets from goldfish cells.

**2005:** the Dutch government agency Senter Novem begins funding research into cultured meat.

**2013:** The first cultured hamburger is created by Dutch professor Mark Post at a cost of almost \$330,000.

**2015:** The first international conference on cultured meat is held in the Netherlands.

**2017:** Memphis Meats fries its first ever \$1,000 lab-grown meatball.

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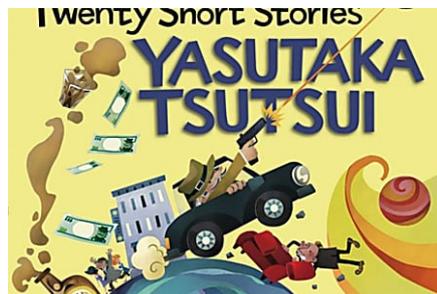
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