



DESIGN + INNOVATION

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Cultured beef developed by professor Mark Post of Maastricht University in the Netherlands. (Photo: David Parry/PA)

All-Beef, No Butcher: Meet the Minds Behind Lab-Grown Burgers

Scientists are pushing to perfect a genetically identical meat that would be better for the environment than cows are.

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Bio



MAASTRICHT, Netherlands—Selling the merits of an all-beef burger to a crowd of vegans and vegetarians is never easy. After all, as any of its proponents might tell you, a meatless diet is a slaughter-free way to eat healthy foods that cause less environmental damage.

Yet, Tobias Leenaert, the cofounder of Europe's second-largest vegetarian organization, Ethical Vegetarian Alternative, found himself making a surprising argument at an April meeting in Belgium.

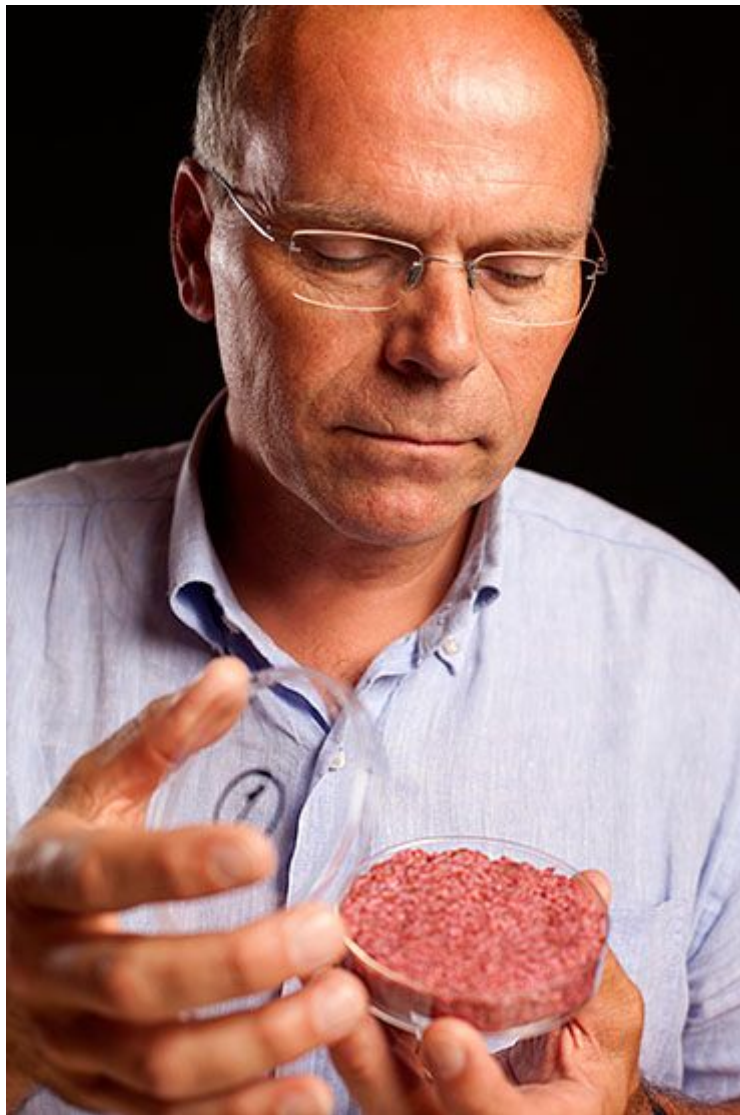
Sometime after the all-vegan potluck brunch and workshops about low-waste living and how to be a good ambassador of the meat-free lifestyle, Leenaert sang the praises of a particular kind of burger: one with a patty made of the lab-grown meat being developed at professor Mark Post's lab at Maastricht University. The lab-grown meat is made of cells harmlessly drawn from a cow and then cultured to grow and form muscle fibers—which means there aren't cows producing vast clouds of methane in the process, and there's no slaughter to atone for.

Theoretically, the harm-free, low-impact meat poses a challenge to some ethical qualms of vegetarians. Leenaert tried to persuade the crowd of more than 150 people to start eating cultured meat once it becomes available, in no small part because it will pull vegetarianism and veganism out of its cult status and prove that the community is interested in solving the overarching problems with meat production.

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Vegans “often believe that we need to use moral arguments only, like ‘Thou shalt not kill animals,’ that attitude change can follow behavior change. So the cultured meat revolution could be the technological revolution that precedes a moral revolution,” Leenaert later told TakePart. “I think it could be the most important food revolution since the invention of farming.”



Professor Mark Post. (Photo: David Parry/Press Association)

The crowd didn't make any promises, and even the creator of the meat isn't too interested in converting vegetarians to eating cultured beef.

"I rather that they not touch it," Post told TakePart, adding that he is on good terms with the Belgian vegetarian community and attends similar meetings several times a year, but "we have slightly different perspectives."

In the quaint city of Maastricht, Post is hard at work with MosaMeat, the start-up newly launched to replace conventional beef with lab-grown ground beef. Before the product begins showing up on menus, the company is less worried about whether vegans or vegetarians will gobble up the beef with zeal and more focused on perfecting the product prior to an anticipated clash between mighty meat lobby groups and regulatory agencies. Taking a satisfying bite out of a tasty cultured beef burger is not that far away, and the product might be very competitively priced against conventional meat.

TakePart caught up with the pioneering MosaMeat team of Post and food technologist and consultant Peter Verstrate, who is MosaMeat's CEO. We interviewed them for our

"[Design and Innovation](#)" series, which highlights the people and cutting edge technology working to solve the world's most pressing problems.

Converting vegetarians to cultured beef is not the priority, confirmed Verstrate.

“I just don’t believe that the majority of consumers will step away from meat,” he told TakePart. “I can see why they say it, but it's not realistic. But that’s OK—it’s not our target group. Our target group is meat eaters.”

For Post, the science behind lab-grown meat is better used to address food security and the [environmental impacts of traditional meat production](#)—particularly raising cattle, which requires lots of land, water, and feed that could be used to grow food for humans. By the United Nations’ estimate, more than two-thirds of all farmland is used to grow feed for livestock, compared with only 8 percent that is used to grow food for people to eat. Add to that the [environmental damage of manure and methane](#) from livestock—of which cattle are the most prolific producers—and lab-grown meat can be especially appealing.

How Cruelty-Free Hamburger Is Made



Scientists take samples of muscle fibers and cells from cows through a painless process.

The cells are cultured so that they divide—a process that can repeat millions of times over.



The cells then form myotubes, which naturally form rings of muscle.



As in humans, cow muscle fibers like to contract and grow bulk—giving new meaning to the term “beefcake.”



Eventually enough beef muscle fibers form to make hamburger (when mixed with fat).



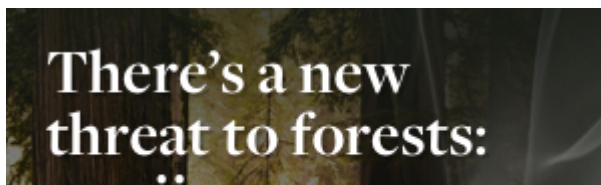
(Infographic: Marc Fusco)

MosaMeat is finalizing plans and funding it needs to scale up operation from a petri dish to a 25,000-liter bioreactor that would produce 882,000 pounds of meat a year—enough for more than 10,000 people who eat an average amount of beef.

In 2013, when the cultured meat burger was unveiled in London, the price tag was more than \$300,000. Nowadays, Post’s best estimate is that an early retail price could be set at \$29.50 per pound, but as production scales up, if the research holds, that price could come down to approximately \$3.60 per pound.

“At first it will likely be aimed at high-end restaurants or specialty stores where people are willing to pay a premium for a product,” Post said.

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To make a cultured beef burger patty, a harmless biopsy of muscle cells is taken from a cow. The cells are nurtured in the lab, multiplying and merging to create strands that grow into muscle tissue. It takes 20,000 strands of muscle tissue for one beef burger. Version 1.0 was pure protein and colored with beetroot.

“It was just muscle fiber, but meat is also fat, connective tissue, myoglobin—which is the stuff that makes meat red, gives it taste. So the burger wasn’t finished. It was a very ‘single-cell’ product, you might say,” Verstrate told TakePart.

Two experts tasted the very pricey burger in London in 2013, with food writer Josh Schonwald saying “the general bite feels like hamburger” and nutrition researcher Hanni Rützler noting the absence of fat, adding that “there is quite some intense taste; it’s close to meat, but it’s not that juicy,” the [BBC](#) reported. Fat may not sound desirable, but as chef Julia Child is known for saying, “Fat is flavor.” Besides, MosaMeat knows that to have a viable contender against traditional beef mince for

version 2.0, it needs to add those missing ingredients. That means growing cultured fat in the lab and having a serum-free medium. The current method of growing cultured cells dates back more than 100 years and has depended on adding blood (serum) derived from cows to the cell-culture medium. Post pointed out that the 2013 burger also contained serum, but that won't cut it for the next version.

Back at the lab, the current method for cultured fat comes from the medical industry. Research from [Duke University](#), for example, indicates cells taken from fat deposits can be “reprogrammed” into replacement cells. But there hasn't been much incentive to experiment with growing fat tissue—and the existing methods for producing fat cells are not compatible with food production.

“We had to redesign that method,” Post explained, “so the next version will have cultured fat added to the cultured muscle.”

They also want to perfect extra ingredients to improve the shelf life of the product, as well as taste and color: a sustainable hamburger that tastes great and is comparable to a traditional hamburger. When version 2.0 of the cultured beef mince is ready, it will be submitted to formal regulatory processes as soon as 2018, though “talking to EU and FDA/USDA representatives informally will probably start much earlier,” Verstrate said. Once the product is formally submitted, the process takes about a year and a half.



(Photo: David Parry/Press Association)

Under EU food guidelines, cultured meat is classified as a “[novel food](#),” a “food that has not been consumed to a significant degree by humans in the EU prior to 1997,” and will need to be approved by a branch of the medical evaluation board. It's comparable to getting a medicine approved: You have to prove you can feed it, safely, to people.

MosaMeat's research has met with a variety of reactions from farmers, the meat industry, food corporations, and supermarket industry executives. Farmers are skeptical—many openly assume cultured meat isn't something they have to worry about in their lifetime. Post thinks the beef industry is waiting and watching for the product to be

launched and marketed before showing interest, though he has some early indication that he's the subject of conversation around some important kitchen tables.

"I heard from a chief executive at Cargill who realized that her [negative] perspective may be skewed when she asked her eight-year-old son, and his response was, 'I'd eat it!' " Post said.

In the U.S., in terms of governmental support, or lack thereof, for sustainable alternatives, the five-year update on the USDA Dietary Guidelines announced at the end of 2015 did not take sustainability into consideration. "We do not believe that the 2015 DGAs are the appropriate vehicle for this important policy conversation about sustainability," the [USDA blog](#) announced.

In April of this year, powerful lobby groups including the National Cattlemen's Beef Association sent a letter to Congress petitioning it to propose a change in the Freedom of Information Act that would prevent the public from accessing interactions between lobby groups and boards that are overseen by the USDA, according to [Fortune](#), which obtained the letter. The move came just a few months after the CEO of the American Egg Board stepped down when emails came to light revealing his attempt to exert pressure on Whole Foods to drop Just Mayo, an egg-free mayonnaise product.

MosaMeat says, however, that it isn't worried about possible negative influence from the beef industry lobby groups.

"I know how powerful they are, but I'm not worried, and it's not because I'm naive," Post told TakePart. "It's because in the Netherlands and the U.K., the governments actually approach **me** to ask, 'How can we make sure that the meat lobby doesn't kill this at the regulatory level?' "

Although MosaMeat has not approached supermarkets yet, it has heard positive feedback from those within the industry. Harvard Business School professor and former Stop & Shop CEO José B. Alvarez told MosaMeat that cultured beef could be a big hit if it could be a consistent product for consumers.

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"That is something that supermarkets seem to like—that you can produce something that consumers know is completely predictable," Post said. "I use that argument myself because I feel strongly about it as a consumer, but nobody ever said it was a great characteristic until the supermarket guy said, 'That's going to be a killer thing.' "

With funding, MosaMeat hopes to work on cultured steak alongside its continued work on cultured ground beef.

"If you want to solve the meat problem, you need to make steaks as well. A lot of meat is consumed that way," Verstrate said.

The big difference between steak and hamburger is size. The hamburger is limited in size, because if the muscle strands become too big, the center will die when it doesn't get enough oxygen or nutrients. That's why we have blood vessels—to carry oxygen

and nutrients to cells and remove waste. To make a steak, you have to provide that channel system, lots of oxygen and nutrients to keep everything alive. You need to create an organ type of structure in which you have not only the tissue but also the blood-vessel-type system.

But cultured steak will likely be a lot more complicated and might require 3-D technology—or perhaps something beyond current imagination. Verstrate told TakePart steak might be developed through another process that doesn't involve printing but that gives the 3-D result. MosaMeat is in talks with 3-D experts and says there might be a simpler solution. Verstrate refrained from elaborating further. In the meantime, while the company applies for more funding, its main focus is on cultured mincemeat.

Post stressed, “My primary concern and the reason why I'm doing this is food security and environmental impact.” The Food and Agriculture Organization of the United Nations describes food security as “access of all people at all times to enough food for an active, healthy life.”



A large cattle stockyard near Yuma, Arizona, like many livestock facilities, contributes to an excess use of energy, concentrated greenhouse gas emissions, and an exorbitant use of water. (Photo: Pete McBride/Getty Images/National Geographic)

By 2050, FAO says, the global population is expected to grow by more than 2 billion people, with most of that growth taking place in developing countries. To keep up with feeding an additional 2 billion people, food production will have to **rise by 70** percent. However, current meat industry practices—from greenhouse gas emissions to water pollution to land usage—are just not sustainable.

In the U.S., agricultural soil management alone accounts for 79 percent of nitrous oxide, which feeds greenhouse gases, according to the [U.S. Environmental Protection Agency](#). Methane gas, water pollution caused when fertilizers run off into lakes and rivers, and large amounts of the greenhouse gas nitrous oxide—emitted from soil when nitrogen is added through the use of synthetic fertilizers—are all due to traditional agriculture and could be avoided with cultured meat.



Estimates vary, but the 2006 United Nations report [Livestock's Long Shadow](#) made an assessment that livestock are responsible for 18 percent of greenhouse gases globally, which is a larger percentage than that produced by transport. Cultured beef could produce up to 98 percent less greenhouse gas emissions compared with the way meat is produced through traditional agriculture, according to a study on the [environmental impact](#) of cultured beef that was funded by New Harvest, a previous financial backer of cultured meat research. Researcher Hanna Tuomisto's 2011 study sets conventionally produced European meat as the standard for impacts on energy, greenhouse gases, and water and land use. The comparison results are stark: Cultured meat could lead to 45 percent less energy use (except in the case of poultry), up to 96 percent less greenhouse gas emissions, up to 99 percent less land use, and up to 96 percent less water use.

Tuomisto also pointed to the difficulty of persuading people to stop eating meat altogether.

“It’s difficult to change behavior. There’s a long tradition in many cultures to eat meat, so it might be easier to change the way we produce meat rather than try to convince people to eat vegetarian products,” she told TakePart.

Cultured meat, however, is not without drawbacks. Energy use could be one of them—and perhaps points to a need for cultured meat producers to team with solar power engineers. An Arizona State University [study](#) published in 2015 proposed that despite the lower risk of greenhouse gas contributions, the production of cultured meat could require more industrial energy than livestock production does, heralding “a new phase of industrialization with inherently complex and challenging trade-offs.”

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Researcher Carolyn Mattick told TakePart a solar power plant could be built to power the cultured meat facility, or a low-carbon electricity source installed on its grid, but also notes this undertaking falls largely outside the purview of cultured meat producers.

“There are a number of ways that cultured meat producers could reduce their products’ carbon footprints,” Mattick said. “Constructing new solar power plants could certainly be one, but another could simply be to improve the efficiency of their production process and reduce the energy required per serving.”

That doesn’t sound bad to Post.

“What I would love to do is to somehow design a system to make it very socially responsible,” Post said, “so that we calculate what resources we save and somehow distribute those resources to people who need it.”

Once that responsible technology is perfected, Post sees a powerful demand for it around the world, and also promises broad accessibility.

“I talked to a minister of agriculture in Zambia who said, ‘This [cultured meat] will never happen in Africa because we don’t have the skilled personnel,’ but I told him it’s a relatively simple process. You could train people. I see the technology going global.”

“We’re not there yet,” Post went on to say, “but it has to be an important part of this company to be very outspoken in its social responsibility.”

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