

Who will win the lab meat race?

Megan Tatum

Not long ago the idea of lab-grown meat sounded like science fiction. Now global startups – from the US, to Japan, Israel and the UK – say they're close to turning 'clean meat' into a commercial reality

In science labs all over the world there is a race going on.

While once the idea of hamburgers grown in petri dishes making their way to supermarket shelves felt like a leap too large for humankind, now the talk is of big breakthroughs later this year, maybe next.

At most, it's only a few years away, say the teams working on the technology from the US to Singapore, Israel and Japan, before cultured or 'clean meat' could be scaled up for commercial availability.

Some are practically there, producing crispy cultured chicken bites grown from extracted cells in vast bioreactors, at sufficient scale to supply high-end restaurants. At a price comparable to conventional meat, too.

That's astonishing progress. Only six years ago the world's first cultured hamburger was cooked up at a cost of more than \$300,000. But research since has been rapid – by 2015 its creator Professor Mark Post had got that price down to \$11 per pound. By next year experts say it could be as low as \$2.30 – less than the average wholesale cost of beef in the US.

The question is, who will cross the finish line first? "That is an excellent question," says Matt Ball of the Good Food Institute, a non-profit set up in 2016 to champion clean meat, as well as other plant-based alternatives. "Per capita, Israel is clearly the leader. But Singapore and India are investing in this better way of producing meat. Mosa in the Netherlands has the longest experience, and companies in the United States have a lot going for them, too."

The fact is, with competition heating up, it's difficult to say. Startups remain increasingly tight-lipped on the details of their techniques and technology.

"When I was trying to start a company in this space I found it was much more collaborative than most nascent startup fields," recalls Seren Kell, co-founder at Cell Ag UK. "People were willing to have conversations and help one another, though of course there is a limit given the need to protect each company's commercial interests."

"Now there are more and more companies, the sense of competition is going up and people are less willing to talk too much."



“Everything is a problem. Every aspect of clean meat – whether it’s the cell line or the bio-reactor – is not optimised yet”

Facilitating more conversation and collaboration was one of the major reasons she and her co-founders set up Cell Ag UK a few months ago. And also because, until recently, the UK has lagged way behind in this global race to create clean meat. “Nobody is talking about it in the UK and lots of people are all over the rest of the world.”

In fact, it wasn’t until a few months ago that Higher Steaks was formed, the UK’s first commercial startup in this space (though there has been academic research for a while) – years after similar ventures elsewhere in the world.

That’s even more puzzling, Kell points out, when you consider that the UK is “per capita one of the greatest countries in the world for scientific output”, producing 15.2% of the world’s most cited research, despite making up just 0.9% of the global population. “The UK should be leading.”

So, why isn’t it? “It’s looking at the landscapes in which clean meat is being developed – primarily in startups and that’s historically not been very British (though things are changing with Innovate UK etc). It’s much more Silicon Valley or Israeli and Japanese. That’s what we’re trying to address as Cell Ag UK. Why don’t we focus on what we’re good at? Which is getting academics in universities working on projects, trying to solve technical challenges facing clean meat.”

Finding solutions to these technical challenges will be what gets the winner over the finish line. Major hurdles include the development of a cost-effective, animal-free alternative to foetal bovine serum (FBS), the nutrient-rich serum extracted from a foetus in which cells grow and develop into muscle and tissue fibres. Then there is the complex scaffolding around which cells take the shape and texture of conventional meat products.

“Everything is a problem,” says Kell. “Every aspect of clean meat, whether it’s the cell line or the bio-reactor or the scaffolding or the media, or all other kinds of components that enter into the process once you start to scale it up, none of those are optimised yet.”

And that’s only the start. “Having a commercially viable product is not the finish line,” adds Ball. “Scaling production will remain a huge challenge, given that meat is a rapidly growing market globally.

As a result “there is plenty of room for more innovators to get into this field, and much more space for investments”. Not least when you consider the regulatory hurdles that need to be overcome before you and I can realistically bite down into a clean meat patty any time soon.”

In other words, it’s all to play for. And here are 10 companies vying to win.



UK 

Higher Steaks

LAUNCHED: 2018

FOUNDER: Chemical engineer Benjamina Bollag and biotech specialist Dr Stephanie Wallis

ITS APPROACH: The first clean meat startup of its kind here in the UK, Higher Steaks uses cells sourced from animal embryos to create lab meat it says has the advantage over adult cells of growing and proliferating indefinitely, without the need for a new batch to be taken from the animal.

It’s opted to look at creating pork. Not only does it have increasing rates of global consumption, says Bollag, but it’s also used in lots of processed products which are easier to recreate. **TIMELINE:** Three to four years for small scale, and four to five years more closely resemble human

cells than other meats, meaning the team can adapt the latest medical technology on humans into their process. They’re starting with sausages and bacon, with a pork chop the most complex product because of its texture and consistency.

PROGRESS: It’s early days, but Bollag says it has already managed to work without the need for FBS and is now focusing on reducing cost, and maintaining consistency in the product. “People underestimate that,” she says. “If you have something half as expensive but which fails one time out of two then it’s not much help.” It’s also looking at manufacturing partnerships.

TIMELINE: Three to four years for small scale, and four to five years for large-scale production.

Canada 

Because Animals

LAUNCHED: 2016

FOUNDERS: Microbiologist Shannon Falconer and former banker and journalist Joshua Errett

ITS APPROACH: Because Animals began life as a producer of plant-based petfood before moving into the lab meat space, the only company of its kind to create cultured meat aimed at pets.

“Most of our ‘competition’ in the clean meat arena consists of human food companies, who are focused on growing tissue from species that appeal to people – namely poultry, bovine and porcine,” says Falconer. “Although commercial catfood is made with the inedible components of meat left over from the human food industry, these are not ingredients that cats in the wild would ever consume. The native diet of the cat consists of mice, insects and small birds. As such, Because Animals is focused on developing food for cats that more closely resembles their ancestral diet – specifically, food made with mouse tissue.”

PROGRESS: By using mouse tissue the company has a distinct advantage in terms of making progress, says Falconer. “In contrast to chickens, cows and pigs, there is a ton of scientific information available on mice,” says Falconer. “Indeed, researchers have been culturing mouse tissue for decades. The same cannot be said for clean meat made with tissue lines that humans would have an appetite for.” As a result the company says it has already managed to develop a serum-free growth media, supplanting any requirement for FBS.

TIMELINE: Early 2020.



Netherlands 

Meatable

LAUNCHED: 2018

FOUNDERS: Daan Luining, who worked with Professor Mark Post, and former management consultant Krijn De Nood

ITS APPROACH: Following an initial R&D process, the Dutch startup says it can create cultured meat hamburgers in three weeks or less – compared with the three years it says it takes to produce conventional meat.

It uses cells collected non-invasively from the blood of a cow’s umbilical cord, and then ‘reprogrammes’ these to behave like embryonic stem cells, ie in a state where they multiply and can create both the muscle and fat cells required to make meat. Though the team are starting with beef, they say the same process can be



applied to other species, including chicken and pig.

PROGRESS: The huge advantage of their technique, say the team, is that it doesn’t require a growth serum such as FBS, removing a huge technique barrier from the process. Their pitch has clearly convinced investors too, with the startup already securing around \$3.5m in funding.

TIMELINE: Within three years.



Mosa Meat

LAUNCHED: 2013

FOUNDERS: Professor Mark Post and food technician Peter Verstrate

ITS APPROACH: Co-founder Mark Post is one of the biggest names in cultured meat, having unveiled the first slaughter-free hamburger (at a cost of \$325,000) to a packed press conference back in 2013. A few months later, Mosa Meat was created with the aim to commercialise his techniques. The company takes its cells from the muscle of an animal while under anaesthesia before placing them in a nutrient-rich growth medium to grow.

From just one sample of a cow, it says it can produce 800 million strands of muscle tissue (enough to make 80,000 quarter pounders) and by layering these together can create meat.

PROGRESS: So far it’s created three hamburgers and “some other small samples” but says production is still at a “very small scale”. It has managed to develop an alternative to FBS but remains tight-lipped on the details. “We can’t share too much information as it is proprietary,” says head of operations Sarah Lucas. All she will say is that it contains “amino acids, growth factors, sugars, minerals and vitamins”.

TIMELINE: Three to four years.



Japan

Integriculture

LAUNCHED: 2015
FOUNDERS: Chemist Professor Yuki Hanyu
ITS APPROACH: The Japanese biotech startup showcased its technique in 2017 using one of the most controversial meat products out there – foie gras. Creating the smooth pâté-like texture of the product, made using liver cells from chickens, requires less technological know-how than a structured steak, for example, which demands far more complex scaffolding to achieve the right shape and consistency. Founder Hanyu has taken a novel approach to garnering media exposure, too, by involving high school students in the process. The chemist claims the concept is struggling to gain a foothold in the US and Europe due to consumer scepticism, and by engaging people in the academic concept from the start they'll become more acclimatised to consuming the final product. As a result, Hanyu took the Shojinmeat Project into Japanese schools, where students were given access to their own microwave-size heated boxes in which to culture cells (at a rudimentary level) in their own homes.
PROGRESS: The company says it has developed a patented “general purpose large-scale culture meat system” that it is working on adapting in pilot and commercial plants. It has already raised 300 million yen from both VC funds and the Japanese government. Using this investment, it plans to achieve price parity with conventional meat by the mid-2020s and says it has already developed inexpensive FBS “substitutes” for the growth serum.
TIMELINE: Its foie gras could be available commercially from 2021.



US

Finless Foods

LAUNCHED: 2017
FOUNDERS: Molecular biologists Mike Selden and Brian Wyrwas
ITS APPROACH: One of the few teams working on cultured fish, Finless Foods first gained attention through its participation in the IndieBio accelerator programme in 2017, where it created the first fish product grown in a lab. It later got investment from Hatch, a Norwegian aquaculture accelerator, as well as Hi-Food, an Italian company focused on sustainability in food. Its process involves sourcing high-quality fish cells that are then ‘fed’ nutrient-rich ingredients to grow in a certified food facility. These are then structured into ‘real’ fish fillets and steaks. The team began with creating bluefin tuna, a species recently threatened by fishing practices, to ease the strain on the population.
PROGRESS: The startup says it is coming to the end of its initial R&D phase, with a recent injection of funds (\$3.5m) allowing it to move into the production phase, having managed to dramatically reduce costs from the \$19,000 per pound prototype. The founders have previously said they will begin by working with chefs in high-end restaurants to “spark a conversation” and encourage consumer acceptance before moving to enter foodservice, and then grocery.
TIMELINE: Has said 2019 “isn’t unrealistic”.



Memphis Meats

LAUNCHED: 2015
FOUNDERS: Uma Valeti, Nicholas Genovese and Will Clem
ITS APPROACH: The US startup has embraced publicity. It first hit headlines in 2016 when it successfully created the world’s first cultured meatball, and broadcast it being fried live in a pan with traditional Italian seasoning. Then again in 2017 when it made the world’s first lab chicken meat strips and invited a select group of taste testers to try it out.

As with other startups in this space, its team creates products by inducing stem cells to differentiate and form muscle tissues, which are then manufactured in bio-reactors. It says its technique can be used for various types of meat. Most recently the US startup made the news again for filing patents that signalled it had begun using gene editing, a way to more accurately select cells, in its technique.
PROGRESS: Its bold PR approach has clearly paid off, with high-profile backers like Bill Gates and Richard Branson. Most recently US meat giant Tyson Foods came on board, investing an undisclosed sum in the company.
TIMELINE: It has changed a few times, but the company has said 2021 is a realistic aim for its products to be in grocery stores.

Just Inc

LAUNCHED: 2011
FOUNDERS: Social entrepreneurs Josh Balk and Josh Tetrick
ITS APPROACH: This US startup began life under the name Hampton Creek, with a focus on plant-based alternatives to foods such as egg (its mung bean version launched in Europe last year). Then in 2017 the team – which includes a mix of prestigious scientists and foodies from elite restaurants – announced it had been working on cultured meat for around a year too. The company doesn’t share much about its process but does use muscle cells grown in bio-reactors. It also says it’s managed to grow cells in “low-serum and serum-free environments”.
PROGRESS: Significant. Its first product – “crispy, juicy cultured chicken bites” – can already be produced at sufficient scale to “supply an innovative, high-end restaurant or handful of restaurants”, says head of communications Andrew Noyes. “Our



production rate has increased substantially in the past year and the amount of meat we are able to create will continue to climb as we increase efficiencies and make new discoveries to help expedite our programme. We are working with regulators in several countries on a clear pathway to offering our product to consumers.”
 In late 2018 it also announced a partnership with a Japanese supplier of Wagyu beef, with an agreement to use the cells from the prize cows to recreate the meat.
TIMELINE: Small-scale production is already possible but more “meaningful” quantities could be two to three years away.

Israel

SuperMeat

LAUNCHED: 2015
FOUNDERS: “Long-time vegans, environmentalists and animal rights advocates” Shir Friedman, Koby Barak and Ido Savir
ITS APPROACH: Alongside Memphis Meats, the Israeli startup was one of the first clean meat ventures to recognise the potential of a strong public profile. It has focused its efforts on creating cultured chicken, setting it apart from some other companies operating in the same space, extracting stem cells from live chickens. To overcome some of the hurdles involved in this process, the company has reportedly ditched its initial aim of growing whole organs, such as chicken breast, and will now focus on processed foods instead, which come with fewer challenges.
PROGRESS: In 2018 it secured \$3m in funding from US-based VC firms New Crop Capital and Stray Dog Capital, as well as ‘strategic’ investment from PHW, one of Europe’s largest poultry producers. This latter investment is proof, say the founders, that the food industry is ready to embrace its technology.
TIMELINE: By 2021.

Singapore

Shiok Meats

LAUNCHED: 2018
FOUNDERS: Stem cell scientists Dr Sandhya Sriram and Dr Ka Yi Ling
ITS APPROACH: The first startup of its kind in SE Asia, Shiok Meats is focusing on cultured seafood, with the aim of creating a shrimp substitute that can compete with the ‘real deal’ as well as a minced shrimp replacement to use in dumplings. In future the pair say they’d like to move into more complex crustaceans, such as crab and lobsters. Already the company estimates it can make a kilogram of shrimpmeat for around \$5,000, which it says is significantly lower than the sums some cultured beefmeat companies are dealing with. Like these companies, it also



uses stem cells to create the fibres and fats needed, which are fed with a nutrient mix. The products created “are healthy and environment-friendly with the same taste, texture, more nutrients and no cruelty” as animal-based equivalents, it says.
PROGRESS: In March the company showcased its prototypes of shrimp dumplings and says it is currently in the process of further R&D to scale up the technology.
TIMELINE: Looking to launch into the Asia-Pacific market in three to five years.