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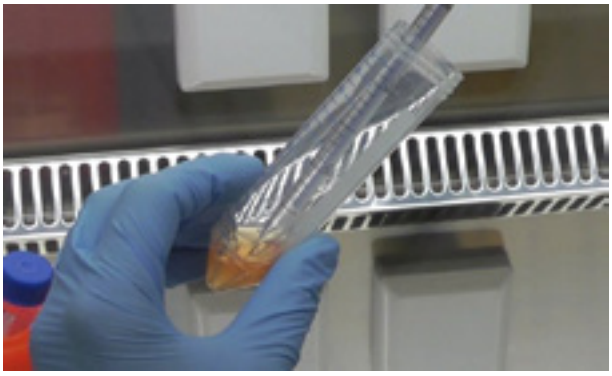
Grow your own meat

By David Cohen

Technology Reporter

Mark Post has been given €300,000 to make a hamburger, in one year. Easy money, you might think, but try doing that without using meat that has come from an animal.



Professor Mark Post: “The basic problem with current meat production is that it’s inefficient”

Professor Post is one of the few people on the planet who can. As head of the department of vascular physiology at Maastricht University in the Netherlands, he is in the vanguard of a new wave of research to create a way of producing meat that cuts out the need for animal husbandry altogether.

Instead of getting meat from animals raised in pastures, he wants to grow steaks in lab conditions, directly from muscle stem cells. If successful, the technology will transform the way we produce food. “We want to turn meat production from a farming process to a factory process,” he explained.

Prof Post is not the first to dream this dream. In the mid 20th Century, Dutchman Willem van Eelen - back then a budding medical student - dreamt of creating meat without killing animals, by using stem cells.

A stem cell is a special type of cell capable of replicating itself many many times and differentiating into specialised cell types, such as muscle cells.

Dr van Eelen pursued his dream for decades, but made little progress. Then in 1999 he was granted a patent on the idea and slowly the world started to take notice.

In 2002, NASA took a passing interest in the idea and funded Morris Benjaminson at Touro College, New York, to investigate making meat from muscle cells as a way to feed astronauts on deep space journeys.

Dr Benjaminson removed a sample of cells from the muscle of a goldfish and managed to

grow it outside the fish's body. The fillet was marinated in garlic, lemon, pepper and olive oil and deep-fried. A panel of testers inspected the fillet and said it smelt and looked just like the real thing, but they weren't allowed to eat it because of US laws prohibiting consumption of experimental products.

Unfortunately, NASA decided there were easier and cheaper ways to feed astronauts, and stopped funding Dr Benjaminson.

In 2005 Dr van Eelen finally convinced the Dutch government to support research into test tube meat to the tune of €2 million.

A series of projects were set up. One explored how embryonic stem cells could be coaxed to become muscle cells, a second study investigated how muscle might be made to grow larger, and a third investigated what sort of growth medium would be optimal for creating steaks in the lab. That money recently ran out and the projects were scaled down.

Then, earlier this year, an anonymous philanthropist got in touch with Prof Post, who for a while worked with Dr van Eelen's colleagues, and offered to pay him to make a hamburger out of Petri-dish pork. "It is likely the most expensive hamburger that we will ever see on this planet," said Prof Post.

Cost of farming

Why go to all that trouble? Take a look at the carbon footprint of meat production, and the justification is clear: livestock farming accounts for around 18% of all man-made greenhouse gas emissions - greater than emissions due to transport.

The UN forecasts that world demand for meat will double by 2050, making that problem much worse. On top of this, around 80 per cent of all farmland is devoted to meat production, and cattle consume around 10 per cent of the world's fresh water supplies. Farming for meat is a very costly process.

Breeding animals for meat is considered inefficient and damaging to the environment

Then there is the animal welfare argument. Prof Post thinks that, deep down, most people feel the way we farm meat these days is less than satisfactory: "I think everybody knows subconsciously that the way we produce meat is not sustainable and isn't friendly to animals."

Echoing this sentiment, the animal rights organisation People for the Ethical Treatment of Animal (PETA) has announced a $1 million prize for the first company to bring synthetic meat to shops in at least six US states by 2016.

Harvest time

So how exactly is in vitro meat made? First stem cells have to be harvested from an animal. Researchers have suggested many different approaches, including enticing embryonic stem cells - the most versatile and potent of all stem cells, harvested from embryos - to differentiate into muscle cells.

This approach has the greatest potential, because one embryonic stem cell, correctly controlled, could potentially produce many tonnes of meat.

But Prof Post believes that controlling the differentiation of embryonic stem cells is too tricky. While we have figured out how to guide embryonic stem cell development in human, rat, mouse and rhesus monkey cells, controlling the embryonic stem cells from cows and pigs has proved much more difficult. “For some reason, we can’t do it and we don’t know why,” he said.

Instead, Prof Post is using cells called myosatellites - a form of muscle stem cell that is normally used by the body to repair damaged muscle.

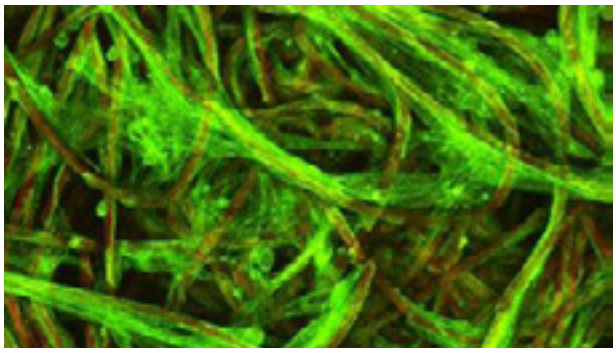
Myosatellite cells can be extracted from a mature animal without killing it and have numerous advantages. Firstly, they are “one way” cells, in the sense that they can only become muscle cells.

Secondly, as the muscle cells proliferate they have an innate tendency to organise into muscle fibres. All that Prof Post has to do to form a strip of muscle is provide anchor points for the fibres to grow around, and the muscle forms by itself. “It’s a bit like magic,” he said.

Exercising meat

For muscle to develop properly, it has to be exercised regularly. This is why people who are bed-ridden for anything more than a few days start losing muscle bulk.

Some researchers have experimented with giving the growing muscle tiny electric shocks to stimulate growth. Prof Post explained that this only improves growth by about 10%, and the energy needed would be too expensive to make meat produced in this way commercially viable.



Meat stem cells replicate themselves and can even be made to exercise

Instead, he relies on the innate properties of muscle cells to exercise themselves. The anchor points - which in his current experiments are small pieces of Velcro stuck to the petri dish - provide tension in the muscle strip. Because muscle cells naturally try to contract, the anchor points provide resistance which in turn causes the muscle to put on bulk in an attempt to increase the force of contraction.

After a few weeks, the muscle cells grow into strips a couple of millimetres thick and 2-3 centimetres long. At present they cannot grow any thicker because there is no way to get oxygen and nutrients into the the cells in the centre of the strip.

If the strip was to get any thicker, those central cells would die out due to lack of oxygen and nutrients.

Long term, Prof Post plans to develop an intricate meshwork through which nutrients and oxygen can travel into the centre of the strip, allowing it to grow thicker, raising the possibility of producing a strip of muscle thick enough to be prepared like a steak. “In principle we could use any animal as a source for our meat. We could use pig meat, fish, chicken, game, any animal that has myosatellite cells in its muscles.”

Now serving

For his first burger, Prof Post intends to harvest a number of these thin strips, mince them up with onion and spices, and then get a celebrity chef to cook up the hamburger. “It would be great if someone like Jamie Oliver agreed to cook it for us, and a famous actress ate it.”

Prof Post thinks a high profile publicity stunt is needed to change the image of in vitro meat. There’s been a mixed reception to the idea so far. He wants to show the public that it is safe and fundamentally no different to eating meat from animals. “Some people think it’s the same as genetically modified food, but it’s not. We use exactly the same process that happens in nature.”

Prof Post hopes that celebrity chef Jamie Oliver will cook the first burger

He points out that until a couple of decades ago we bought cheese from farm houses, and yet today virtually all cheese is made in factories. “Why should meat be any different?”

Killing animals for meat may become a thing of the past, but producing meat in this way will still require some animals. “We will still have farms because we need small donor herds to provide stem cells. So there will be a low level of livestock breeding and keeping. But it will be a tiny fraction of what it is today.”

Perhaps one of the trickiest hurdles that Prof Post and his colleagues are yet to overcome is the taste of in vitro meat. “We don’t really know where the taste of meat comes from,” he said. “We assume it comes from fat, but there may be other components, most of them are unknown so it’s a bit of a mystery how the conditions we use during the culturing of the meat will affect the taste.”

The only person known to have tasted in vitro meat was a Russian TV journalist who visited the lab last year. “He just grabbed it out of the dish and stuffed it into his mouth before I could say anything,” said Post. The taste? “He said it was chewy and tasteless.”
