BEYOND THE FUTURE OF LAB-GROWN HAMBURGERS

Besides reducing land and labor needs, impacts on environment and the risk of animal-borne diseases, cultured beef can also help improve food security. There is a long way to go before it makes it way to restaurant menus, but this technology may well change the future.

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STEM cell technology is slowly ‘growing’ out of its role in the clinical armamentarium against disease and ultimately may make its way to our refrigerators and fast food menu boards. Lab-grown meat uses cells harvested from animal tissue that can be cultured, multiplied and turned into edible meat products.

Dr. Mark Post, professor of physiology at Maastricht University Netherlands, is the lead scientist for this futuristic technology. The idea and technology has been lingering around for a while now. However, the recent spike in media coverage seems like a well-orchestrated effort to raise awareness and funding.

Coincidentally (or not?), the co-founder of Google, Sergey Brin, has already invested substantial assets in order to push this stem cell technology to the next stage. Is cultured meat doomed to fail or here to stay?

STEM CELL TECHNOLOGY

The myosatellite cells—or adult stem cells that are only able to become muscle cells—are programmed to form myofibrils in unison as they multiply and as such are strikingly similar to skeletal muscle tissue in vivo. The result is tissue that is biologically similar to the meat from which it was harvested.

The technology basically comes down to allow a small sample of muscle tissue to be separated into individual cells that are subsequently placed in a nutrient solution (medium). These cells are then nurtured to allow multiplication to create muscle tissue grown outside the animal.

The cells naturally merge and rearrange into small myotubes. These myotubes are grown around gel hubs similar to a doughnut shape, contracting and creating bulk tissue. A single strand can actually multiply to trillions of new strands which—when layered together—replicates meat tissue.

About 15,000 strands are needed to make a 100 g or four oz burger patty. For now, the most obvious reengineered tissue research is done to duplicate beef. The overriding reason is that beef has a very long outgrow cycle demanding extraordinary amounts of clean fresh water and feed. Generally, about nine kg or 20 lbs of feed and 2,000 litres or 520 gallons of water are needed to generate one kg or 2.2 lbs of lean beef.

In vitro meat production using stem cells, also dubbed cultured meat, is possibly an ecological and sustainable alternative to the economically inefficient livestock outgrow cycles. Currently, 70 percent of all agricultural land, corresponding to 30 percent of the earth’s surface, is being used for livestock production in both grazing pastures and securing food stock.

Cultured beef could, therefore, reduce the need for agricultural land and labor-intensive feedlots dedicated to meat harvests and substantially freeing up space to grow crops to be eaten directly by humans without a transitory transformation.

Besides improving ethical standing and food security, cultured meat could also help to significantly reduce the risk of animal-borne diseases like salmonella and E. coli, or even BSE, which causes mad cow disease. The ad-
Larger pieces of cultured muscle cannot receive enough nutrients in its core due to the lack of a vascular system for the transport. Moreover, the in vitro proliferative capacity of myosatellite cells is far inferior to embryonic stem cells and therefore, needs to be improved on in order to obtain a commercially interesting culture time.

Embryonic stem cells (which can form all cell types in the body) are not used due to the difficulties encountered when trying to direct the cells for only muscle tissue generation. Another important issue is that cultured muscle cells by themselves have not yet resulted in a satisfactory product because of their inability to fully mature to functional muscle, which can contract. Biochemical signals can be provided via bioactive proteins called growth factors, in order to help the

HURDLES TO OVERCOME

It is obvious that cultured beef should be considered as a serious alternative in the future. However, many hurdles stand in its way before it arrives onto the consumer’s plate.

As previously explained, the technology currently uses myosatellite cells as a basis to grow the meat. However, currently, the size and shape to which the muscle pieces can be cultured is limited to 1.5 x 0.5 x 0.15 cm.

advantages can even be extended onwards and have indirect implications on human health in general, possibly reducing the risk of cancer, cardiovascular disease and type 2 diabetes in particular.

This futuristic option to grow meat could greatly reduce ecological and environmental stress factors such as clean water, energy use, emissions of methane and other forms of greenhouse gases that are some 20 times more potent than carbon dioxide.

According the Food and Agriculture Organization of the United Nations, about 18 percent of all greenhouse gas emissions are generated by livestock production, more than all global transportation sectors combined. The anticipated huge increases in world meat demand by the rapidly increasing population will surely further increase stress levels of greenhouse gases.
muscle cells mature and differentiate into functional tissue. However, these growth factors are often isolated from animal sources like fetal calf serum or are made by recombinant DNA technology, subsequently limiting its use in cultured meat technology.

So for now, myosatellite cells are the way to go, and luckily, there are some tricks up the researcher’s sleeves that might accelerate the growth rate and overall quality of the cultured beef.

For example, it is important to mimic the in vivo conditions during the culturing to ensure that the formed muscle really resembles the real thing. These conditions may be partially simulated by providing biophysical stimuli in the form of mechanical and electrical contractile stimulation. These methods have proven to be successful in the maturation of the muscle pieces towards functional tissue with native properties. Moreover, the myosatellite cells can be cultured together with other cell types, which help the formation of the extracellular matrix to which the muscle cells can adhere. This so-called ‘co-culturing’ of cells ensures that the composition of the cultured muscle is starting to resemble the in vivo situation.

PERCEPTION IS REALITY

Consumer acceptance and perception is almost even more important than the technological hurdles that have to be taken. In order to gain consumer acceptance the sensory appreciation and quality of the products have to be spot-on.

It will be essential to combine cultured beef with other animal tissues such as fat, connective tissue and blood. The red colour of meat is created by the proteins haemoglobin and myoglobin. Myoglobin can be found in muscles, and commercially available haemoglobin isolated from red blood cells can be added to the cultured meat products as natural food colouring.

In the future, stem cell technology can be used to produce in vitro red blood cells, once again eliminating the need for animal blood. What might prove to be most important feature: flavour, taste and texture organoleptic parameters will be the fat present in the final product.

Let’s face it, cultured beef flavour and texture will only be appreciated by consumers, if fat is part of the equation. After all, fat is the carrier of flavour and typically some 20 percent of fat is needed in a hamburger to provide for the highest degree of organoleptic satisfaction. Not surprisingly, the technology to use stem cells to grow fat is already known.

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and like cultured meat, still needs refining before actual mass production can be upscaled.

For now, it is expected that science will need at least another 20 years before the first commercial production stem cell based tissues are economically and technically feasible.

FAT SIMULATION WITH PROTEIN

An alternative and much cheaper method to incorporate the much needed fat into a cultured meat hamburger is the use of micro-stabilised vegetable oil globules by using milk protein or plant protein sources that have microparticulation properties to simulate fat.

Actually, it is even possible to prepare a double emulsion in which the inner-layer can contain nutraceuticals, vitamins and minerals such as iron. This fat-simulation technology is already widely used in many meat and food products.

Besides improving texture and juiciness, it will significantly reduce the amount of saturated fat. High amounts of naturally occurring saturated fatty acids in meat fats are known to significantly increase the risk of heart disease.

Since more than 50 percent of all beef is eaten as ground meat, it is obvious that hamburger versions will draw most attention and probably are the fastest way forward to bring this technology to market introduction. Here in the ground meat market, it is where other protein sources can, and will, excel and gain interest, just like the cultured meats.

For example, using texturised vegetable proteins to mimic meat structure has recently been introduced and is now being used by the world’s leading fast food companies as well as organic whole foods companies. Subsequently, it has started to find its way into our everyday food and hybrid meat products. Structured and/or texturised proteins mimicking chicken, ground beef and fish are used in meat-free or vegetarian products, as well as frequently blended with meats to form hybrid products.

INSECTS ANYONE?

Proteins from insects are of high quality and can also be structured to mimic animal tissues. Moreover, insect protein hydrolysates can be added to vegetable proteins to supplement the essential amino acids. Next to bacteria and fungi, insects are one of the most efficient organisms on this planet, which need little nourishment and energy to flourish.
The technology and knowledge behind insect culture has been around for years and will offer many of the same advantages cultured meat does. It is safe to say that, despite these technologies seeming like competitors, they work towards the same goal of sustainability.

MORE FROM LESS
It is still too early to know for sure, but it is estimated that one single bovine cell sample (taken from the cow’s shoulder) could produce 20,000 MT of cultured beef. Translated into McDonald’s language, this would mean that more than 175 million quarter-pounder hamburgers could be served.

Since cultured beef will not appear on the menu boards sooner than 2030, it is safe to assume that by that time, these cultured beef burgers would be infused with structured plant protein fibres that uniquely mimic organoleptic meat properties including texture, juiciness, flavour and colour.

Combining premium sources such as soy protein, wheat, and rice bron protein makes these structured plant protein fibres an ideal solution to further stretch cultured meat. By going this pathway, truly sustainable and cost efficient hybrid meat products can be produced that will have a very satisfactory consumer appreciation level.

As such, it can be assumed that for coarsest ground meat foods, the infusion or blend level will be about 50 percent cultured beef, and 50 percent of structured plant-based meat analogue fibres that completely match the characteristics of lean meat.

Extrapolating the numbers in the previous paragraph, it would translate to about 350 million burgers or the equivalent of 800,000 cattle. Think about the huge amounts of savings that can be generated, including less intensive livestock farming and of course, a much higher standard of animal wellness (ie: no need to slaughter).

For now, still many more years will be needed before cultured meat might appear on the menu boards of fast food restaurants. Until then, it will be paramount to engage the consumer in a meaningful dialogue to clear the pathway for general acceptance. After all, the highly intense GM-debates and confrontations with special interest groups such as Greenpeace have shown the food industry how to avoid the pitfalls of groundbreaking technology and its potential consumer impact.