



A steak in the future

Even if we can grow cultured meat, should we?

A report of the Business Forum meeting
on Tuesday 27th January 2015

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About the Business Forum

Ethical questions around climate change, obesity and new technologies are becoming core concerns for food businesses. The Business Forum is a seminar series intended to help senior executives learn about these issues. Membership is by invitation only and numbers are strictly limited.

The Business Forum meets six times a year for an in-depth discussion over an early dinner at a London restaurant.

To read reports of previous meetings, visit foodethicscouncil.org/businessforum.

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Introduction

Cultured (or in vitro or lab-grown) meat uses tissue growth technology developed for organ transplants to create muscle tissue which can be formed into processed meats such as burgers and sausages. The launch of the first 'cultured beef' burger in 2013 (at a cost of \$250,000) generated huge media attention.

Cultured meat is generating both excitement about its potential and concern about the possible unintended consequences from its further development. Some claim the possible animal welfare and environmental benefits mean "this could be a real game changer" (Philip Lymbery, Compassion in World Farming). Others raise ethical concerns, including whether it will reinforce the industrialised food system paradigm; the extent to which it may increase disconnection between people and their food; questions over who will own this technology and who will be able to afford to access it.

Exploring cultured meat – as one of a range of potential solutions – acts as an entry point for related and important issues, from meat consumption to the acceptability of new technologies. Proponents of cultured meat claim it could be healthier, safer, less polluting and more humane than conventional meat. But critics point out that it may not be a silver bullet that provides the world with guilt-free protein.

The January 2015 meeting of the Business Forum explored the current technology advancements in cultured meat; implications for different players within the meat industry; how society could adapt to such technology; and what is needed for a formal debate around cultured meat to take place.

We are grateful to our keynote speakers, Dr Marianne Ellis (Senior Lecturer in Biochemical Engineering, University of Bath) and Dr Neil Stephens (Cesagen Research Associate, Cardiff University). The meeting was chaired by Jon Alexander, Founder of the New Citizenship Project and member of the Food Ethics Council.

The report was prepared by Anna Cura and Dan Crossley, and outlines points raised during the meeting. The report does not necessarily represent the views of the Food Ethics Council, the Business Forum, or its members.

Key Points

- Eating meat is an important part of culture in many societies. Cultured meat is trying to be like meat, but in a way that radically reduces the need to farm animals. Cultured meat's emergence begs questions such as 'is cultured meat real meat' and 'if it is not real, what is it?'.
• Cultured meat uses tissue growth technology to create muscle tissue which can be formed into processed meats. Cultured beef has received the most attention to date, but cultured milk, chicken and leather are all in development. It is likely to be a number of years before cultured products become commercially viable.
- Given that alternatives to meat already exist (e.g. Quorn, tofu, legumes, etc.), will cultured meat's potential be any greater than existing options?
- Proponents of cultured meat argue it has the potential to bring significant benefits, particularly in relation to animal welfare and environmental impacts. Some believe it could be a 'game changer'.
- Critics raise serious concerns, such as the extent to which this 'lab-grown' food may increase disconnection between people and their food, as well as questions over who will own it and who will be able to afford to access it. Given that technologies are continuing to evolve, many are likely to argue the need to exercise caution and to adopt the precautionary principle.
- No matter how debates around cultured meat develop, it is vital that it is not painted as a 'silver bullet' for the world's food security problems. It is equally important that the technology is not dismissed based purely on instinctive reactions.
- Cultured meat should perhaps be presented as one of a suite of possible solutions that *could* play a role in the future, but – crucially - key stakeholders need to understand the technology and its likely impacts in more depth before passing judgement. Citizens should all have a stake in their future. Whether that future *will* involve a (cultured) steak is still uncertain. And whether that future *should* involve cultured meat remains open to debate.

What is cultured meat?

What first comes to mind when referring to cultured meat is most likely the lab-grown burger, the story of which went viral in the summer of 2013.¹ But what really is cultured meat? The definition is still unclear, and although at the moment it typically refers to beef, similar processes are being applied to a range of products from chicken to leather, and from eggs to milk.

Cultured milk may be easier to produce than meat, as there is no cell culture involved and biological molecules are easily created in a lab. Therefore it was argued that cultured milk is likely to be commercially developed before cultured meat.

Cultured meat is not a new idea. Much of the early work on its development was to explore cultured meat in relation to space travel, i.e. whether it could be food for astronauts. Recently there has been a surge in interest and technological advancement. Motivations for its development have changed over time and are likely to change again.

The recipe

Although there are a number of different technologies exist for growing cultured meat, a typical process follows a series of steps:

- Cells are sourced from a live animal via biopsy. These can be either stem cells or specialised muscle cells. This implies that cattle herds are not likely to disappear even if cultured meat becomes the norm, although questions remain as to how stem cells would be sourced.
- Cells are then transferred to a growth medium, normally serum from cow fetuses. This typically involves killing a pregnant cow. Aside from the health and animal welfare concerns associated with this method, it is also expensive, at \$250 per litre of nutrient solution (three cow fetuses). There is currently research into possibly synthesising or artificially manufacturing an alternative growth medium for cultured meat.

- Muscle tissues are formed in the nutrient solution around a scaffold and then fused to create muscle.
- The muscle is stretched and electric shocks applied to it. This process builds up the protein content.
- The culture sits in a bioreactor, which is the most energy intensive step of the process. It may be possible to use solar energy in the future to reduce the environmental impact of this stage.

Although there may be commercial potential for cultured meat, it was suggested that there is still a long way to go to get to a 'viable product', especially when it comes to taste, texture and costs of manufacturing.

The lab chefs

The cultured meat community, although global, is still very small. Mark Post is the most well-known actor in the field, being behind the first lab-grown burger eaten in London, after receiving US\$330,000 in research funding. His work is ongoing.

A few organisations and private companies have appeared around the globe, embracing, researching and promoting this new potential market. New Harvest² has worked extensively on promoting cultured meat. Other organisations working in the field include ModernMeadow³, which focuses on cultured leather, and Hampton Creek⁴, with its Just Mayo, a plant-based product. Both are funded by Li Ka-Shin, at US\$10m and US\$30m respectively.

Muufri⁵, a recent start-up, is developing animal-free milk, and has ambitious goals of having its product ready for the market within the next six to nine months. In less than one year, the company has already secured US\$2m in funding. In January 2015, the Modern Agriculture Foundation and Tel Aviv University launched a world-wide project on chicken tissue engineering⁶.

¹ World's first lab-grown burger is eaten in London - www.bbc.co.uk/news/science-environment-23576143

² www.new-harvest.org

³ modernmeadow.com

⁴ www.hamptoncreek.com

⁵ muufri.com

⁶ futuremeat.org

What impacts should be considered...

1. ...for the environment?

In many developing countries, where meat consumption has doubled since 1980, there is an increased desire to switch to a western diet. Currently, 33% of productive land globally is used for raising livestock; 14.5% of greenhouse gas emissions come from livestock farming, and land conversion to feed crops is a major driver of deforestation.

It was suggested that there is a very strong sustainability and environmental protection argument for cultured meat. The introduction of cultured meat onto the market could have huge impacts on agriculture, and it was claimed that it might realistically contribute to reducing conventional livestock production by 20-25% (albeit any predictions about emerging technologies should be taken with a dose of caution).

A study from Tuomisto and Joos⁷ compared environmental impacts of cultured meat versus (conventional) beef rearing, with early figures suggesting that there could be potential for greenhouse gas emissions and land use to be reduced by 95%, although energy use would be about the same, pending further research on bioreactors. Any energy and carbon related impacts of cultured meat would need robust data in order to claim that 'cultured meat could be the most nature-friendly meat'. Further research is needed to substantiate such claims.

A source of original and harvestable cells would still be needed, and therefore farmers would have to keep small herds. However, how this might impact the current cultural and agricultural landscape remains open to question.

Concerns were raised that a shift to eating cultured meat may further increase people's disconnection from nature and hence mean people value food even less than they currently do.

2. ...for our health?

As with most new technologies, there is currently no research looking at health risks associated with cultured

meat. However there are concerns over its consumption, in particular due to the potential use of 'immortal cells' in the cell growing process.

Overconsumption of meat has been associated with health issues, including high cholesterol or coronary heart disease. Engineering meat could potentially include reducing saturated fat content and adding healthy ingredients, including vitamins and amino acids, to produce a 'meat+' product.

To a lesser extent, some suggest that cultured meat could help in the fight against global food poverty, although others believe this is a politically driven argument.

On a farm level, proponents argue that managing smaller herds could help tackle difficult or dangerous animal to human diseases and associated antibiotic use, and that cultured meat could potentially be 'cleaner'.

3. ...for farmed animals?

Another advantage of cultured meat put forward by its proponents, is a reduction of animal slaughter. If it becomes commercially viable, advocates argue that cultured meat could play a role in replacing some of the worst excesses of factory farming. Ethical concerns remain however, particularly while foetal serum is used as a growth medium.

What meat represents to society

Is cultured meat real meat? What makes it real? And if it is not real, what is it - a meat substitute? These are questions that still need answering in framing discussions around cultured meat. Different stakeholders answer these questions differently. When asked, scientists often describe meat as a list of attributes. Sociologists consider a product as meat when people treat it as so. There is currently no consensus, which is exacerbated by the current lack of conferences, meetings or even scientific journals that specialise in this new technology. Alternatives to meat already exist (e.g. Quorn, tofu, legumes, etc.). What this new technology aims to achieve is a product that is identical to meat protein (in taste and texture) but radically reduces the need to farm animals.

⁷ Hanna L. Tuomisto and M. Joost Teixeira de Mattos (2011) Environmental Impacts of Cultured Meat Production. *Environmental Science and Technology* 45(14):6117-23

Parallels and reference points

In relation to cultured meat's future development, it was suggested that there may be lessons to be learned from debates about GM technology, and levels of public acceptability across Europe.

There is a need for potential users and funders to be better informed about cultured meat (and other alternatives) in order that either its potential can be optimised or decisions are made not to develop it further. It was suggested that there must be a well-rehearsed methodology by academics to study new technologies.

Recent work on industrial biotechnology argued that questions which should be asked are not 'is it safe?', but 'do you want it to be safe, and if so, how do we get to that point?'. Perhaps similar questions should be asked of cultured meat?

It was suggested that cultured meat has the potential to be a 'game changer' for society in a similar way to the iPod/ iPhone or facebook. Clearly it is too early to say whether or not such transformative impact is realistic or simply a fanciful dream concocted by those promoting the technology.

A viable future?

Assuming for a moment that the technology does continue to develop, the discussion turned to how might a market for cultured meat emerge, and what might it look like? Whether the movement might roll out on an industrial scale, or splits into multiple local 'meat breweries' will depend in part on economies of scale.

Current models for cultured meat production are still far away from being replicable on a large scale or financially viable. Current conventional livestock production represents millions of tonnes of meat every year. It was suggested that ambitions to completely replace current 'conventional' practices are unrealistic, but the extent of cultured meat's impact will depend on how research evolves. It is possible that cultured meat might be produced on a small scale and appeal to more wealthy citizens as an 'unusual delicacy'.

Tissue engineers might argue that a basic cultured meat product could be produced within the next two to three years – *if costs are not a determining factor*. However,

current research is (understandably) trying to reduce high costs and, whilst it is impossible to give an accurate timeframe, it was claimed that a cheaper alternative to current practices could feasibly be available within the next five years. For something that approaches 'real' meat, it was suggested that at least another decade is likely to be needed. This is dependent on what can be achieved in the biochemical sector – developing not just muscle cells, but also nerve cells, fat cells, blood vessels, and recreating the meat flavour.

To trust or not to trust?

Inevitably, whether or not a new technology is acceptable to people will depend heavily on trust. In the food system, trust is often linked to the 'most natural product'. Cultured meat challenges that idea and therefore may come up against trust issues. What for example would go on a cultured meat product label? If the product was clearly labelled as produced in a lab, would people feel reassured that the ingredients list is 'clean' (having been produced in a sterile laboratory) or would they reject the product as artificial and unattractive?

Different regions of the world might also react differently to this emerging technology. The USA, which is already quite open about GMOs, may be more likely to embrace such a technology than other nations. If the technology creates a product that is indistinguishable from the original, would that reduce or increase ethical concerns about its origins?

The EU may be a difficult market for cultured meat. With its precautionary approach to new products, the EU can be more restrictive, which may mean the cultured meat community looks at other markets. NGO voices arguably also have more impact on many markets in the EU than some other regions, which is likely to influence confidence among the wider public on these new technologies.

Some people are likely to be excited by the idea of eating this 'future food', whilst others may be put off by the 'yuk factor' of eating food grown 'in a petri dish'. Different stakeholders will have different reasons to be variously curious or distrustful of this new technology.

For cultured meat to be trusted and accepted more widely, a shift in culture, in parallel with advancements in the technology, would need to happen. Cultured food would need a different food culture. The technology

itself also needs to adapt to different cultures. Whether such a major behavioural change will happen remains to be seen.

Regulation

The Food Standards Agency is already getting prepared for potential independent safety assessment of cultured meat, following EU regulation on novel foods, which gives an indication that such new technology is expected to hit the market within the next 10 years. However, there appears to be a lack of consensus at the EU-level. It was suggested that in the UK, new food technologies have been encountering increasing regulatory issues.

If future UK governments are reluctant to regulate new food products, and the EU is unable to establish a set of guidelines, it may be left to the industry to self-regulate and build trust. It may be that the scientists themselves could help create guidelines and principles for 'safe' cultured meat. Currently cultured meat is being created following strict medical grade guidelines, but as more players enter the field, this may change.

As this new technology develops and (potentially) generates profit, there are important questions to consider around intellectual property rights and ownership of the technology.

Shaping the debate around cultured meat

The debate around cultured meat is still in its infancy. Scientists are starting to ask questions of the general public about how acceptable the technology is. However there is not currently a framework to do this effectively. As the product is not 'market ready', it can be difficult for the general public to conceptualise the product and make informed rational decisions.

Dialogue is being shaped by scientists and a few private companies. There is a need for an open and wide-ranging debate about cultured meat – bringing in key stakeholders, including leading NGOs, food businesses and government. Public consultations – when done well (as the case was for GMOs) – can be very powerful. Will the future narrative on 'cultured' or 'in vitro' or 'lab-grown' meat be driven by advertisers or by citizen dialogue?

The food industry has not yet become heavily involved in debates about cultured meat, which may be because

the technology is still some way from being commercially viable. A responsible innovation framework was proposed as being a useful way to consider optimum benefits and risks for cultured meat.

Reflections

Is the debate wrongly placed, and should we question the notion that it is inevitable there will be an increase in meat consumption before thinking about how to meet the demand?

No matter how debates around cultured meat develop, it is vital that it is not painted as a 'silver bullet' for the world's food security problems. It is equally important that the technology is not dismissed based purely on instinctive reactions.

Cultured meat might perhaps be best presented as one of a suite of possible solutions that *could* play a role in the future, but – crucially - key stakeholders need to understand the technology, and its likely impacts, in more depth before passing judgement. Given the stage the technology is at, now seems a pertinent time to critically explore the ethical issues relating to cultured meat and to consult openly, in order to shape its future direction.

Citizens should all have a stake in their future. Whether that future *will* involve a (cultured) steak is still uncertain. And whether that future *should* involve cultured meat remains open to debate.

Speaker biographies



Dr Marianne Ellis is a Senior Lecturer in Biochemical Engineering at the University of Bath and a Royal Academy of Engineering/The Leverhulme Trust Senior Research Fellow. Her research interests are focused on bioreactor and bioprocess design for the scale up of cell therapies and cultured meat, and to produce physiologically-relevant in vitro models for toxicology and bioartificial organs. Her interest in cultured meat began at TERMIS 2012 when she was asked to carry out a detail bioreactor energy balance for growing meat. Marianne studied for a BEng in Chemical & Bioprocess Engineering (2001) and a PhD in Biochemical Engineering at The University of Bath (2005), before becoming a postdoctoral researcher and taking up an academic position in 2005. She is a Chartered Engineer and Member of the Institution of Chemical Engineers; Leader of the Biochemical & Biomedical Engineering Group at Bath; a Deputy-Director of the Bath Centre for Regenerative Medicine; and a Board Member of New Harvest. Marianne's core research is cell therapies and tissue engineering, working with the end user in mind, be it surgeons, drugs companies or consumers. Projects range from expanding regulatory T-cells to (in the future) replace immunosuppressant drugs, to developing an in vitro model for liver with Unilever, Astra Zeneca and Syngenta.



Dr Neil Stephens is based in Cesagene at Cardiff University School of Social Sciences. He is a sociologist focused upon innovations in biomedicine and stem cell science. Since 2008 he has been analysing the use of cell culturing techniques to produce meat. He has conducted interviews with many leading scientists, funders, and stakeholders active in the field. His research has focused on the relationships between future-orientated visions for the technology, the networking of the individuals involved, the production of ethical accounts and the broader social context. His work on in vitro meat has been published in the journals *Configurations* and *Scripted*. He has conducted other projects about human embryonic stem cell and cancer tissue banking, and the African-Brazilian dance form Capoeira.



Jon Alexander is founder of the New Citizenship Project, a nascent thinktank and consultancy specialising in promoting the role of the individual in society beyond that of the Consumer. Jon worked for a decade in advertising and marketing with a continual bent to finding ways to apply the skills of the industry for genuinely positive social and environmental ends. He piloted an idea called MyFarm with the National Trust in 2010, an early experiment in promoting participation rather than consumption. This led Jon on to Project Wild Thing, a feature length documentary project which aimed to reconnect children with nature and which led to the establishment of the Wild Network, a collaboration of over 1,500 organisations committed to tackling the issues raised in the film. Jon is a passionate believer in the power of creative thinking, but an equally passionate advocate of thinking rather harder than we currently do as a society about how we use that power. He speaks widely on this subject, including several appearances on Radio 4 and a forthcoming TEDx talk, and holds three Master's degrees, in Classics, Responsibility and Business Practice, and Global Ethics and Human Values. Jon is a member of the Food Ethics Council.