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Benevolent technotopias and hitherto unimaginable meats: Tracing the promises of in vitro meat

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Abstract

Today, in vitro (Latin: in glass) meat researchers strive to overhaul meat production technologies by producing meat outside animal bodies, primarily by culturing cells. In the process, meat should become healthier, more environmentally friendly and kinder to animals. In this article, I scrutinize (and problematize) this promissory discourse by examining the world that proponents envision alongside the world from which promises emerge. First, I trace the increasing number of publications striving to pinpoint the nature of in vitro meat to unveil the creation of an in vitro meat canon wherein perceived possibilities become taken for granted. Second, I investigate how the promissory discourse is often relatively silent on key aspects of how this technology could remake the world. Wet laboratories, animals and end products become foregrounded at the expense of political economy and the biophysical properties of cultured cells. Thus, questions concerning how funding requirements shape representations of this new technology, together with in vitro meat's particular socio-spatial and socio-ecological implications, become problematically de-emphasized.

Keywords

biotechnology, discourse, food, meat, venture capital science

In 2013, an estimated 310 million tonnes of meat was produced worldwide; a 73 percent increase from the 180 million tonnes produced just over two decades earlier, in 1990 (Food and Agriculture Organization [FAO], 2015). Sustaining such levels of meat production, and the production of other animal-derived products, requires a

global livestock population of 29 billion (the vast majority of which are poultry), growing by 82 percent between 1990 and 2012 (FAO, 2014). Each year, an increasing number of non-human animals are thus reared to be killed for human consumption. The conditions under which many of these live and die have for long been considered unacceptable by a range of vegetarians, vegans and other animal welfare activists (Stuart, 2007). But lately, livestock lives have also become a prominent focal point for discussions on environmental issues.

A 2013 Food and Agriculture Organization (FAO) of the United Nations report attributed 14.5 percent of all greenhouse gas emissions to livestock industries, with beef alone contributing to almost 6 percent (Gerber et al., 2013). Meanwhile an earlier, widely circulated, FAO report stated that livestock (for both meat and dairy production) used 70 percent of all agricultural land, if both grazing and feed crop production are accounted for. Livestock industries are simultaneously sources of emissions, such as ammonia, and account for 8 percent of total human water use (Steinfeld et al., 2006). Livestock-induced environmental effects are, moreover, projected to escalate with expected increases in meat and dairy demand. Consequently, a range of projects targeting production processes and/or diets has been initiated. In this article, I focus on a high-profile example of such a project, namely, recent attempts to produce meat outside animal bodies, so-called 'cultured' (Datar, 2016) or in vitro meat (in vitro, Latin: in glass). Here, erstwhile biomedical technologies surface as food production strategies for producing a new kind of meat, for a new kind of world.

On 5 August 2013, the world's first in vitro-produced burger was triumphantly unveiled at a tasting event in London. Starting with small muscle pieces acquired through biopsies conducted on two living cows (a Blonde d'Aquitaine and a Belgian Blue) raised on organic farms, this burger was produced by first separating muscle cells from the tissues biopsied and thereafter culturing the separated cells. When cells had organized into myotubes (tubular skeletal muscle fibre), these were placed around agarose gel central hubs in culture dishes, causing them to self-organize into 1-mm-diameter donut-shaped muscle fibres. A total of 10,000 such minuscule muscle strands enabled assembling an 85-g burger (Maastricht University, 2013a; Post, 2014a).

Once assembled, this burger was cooked and presented to Mark Post, the Professor of Vascular Physiology leading the Maastricht University team producing it, to Josh Schonwald (2012), the author of a book on future food 'game changers' wherein in vitro meat was labelled '[t]he guilt-free, heart-attack-fighting super burger'

(p. 124), and to Hanni Rützler, a nutritional scientist. Attended by 200 journalists and academics, and broadcast online on a TV-show format led by ITV newscaster Nina Hossain (moderating the discussion and asking those watching to tweet about the event), this amounted to a spectacular unveiling of a kind of meat supposed to be both environmentally friendly and kinder to animals (see Cultured Beef, 2013a; Post, 2014a).

The question is, however, just *what* was unveiled that August day? What does in vitro meat offer? Stephens (2010: 400; see also Stephens, 2013) has called in vitro meat an ‘as-yet undefined ontological object’, while Van Der Weele and Driessen (2013: 651, 657) refer to the future of this meat as ‘still largely ... an ontological void’ that ‘can be filled in very different ways’. And indeed, labelled ‘soulless meat’ by proponents of conventional meat and accompanied by attempts to find ‘an appealing name ... that would diminish its monstrous character and focus attention on its potential benefits’ (Driessen and Korthals, 2012: 808), the character of in vitro meat *can* appear uncertain. While names such as ‘Labchops’ and ‘Meat 2.0’ have previously been put forward (Driessen and Korthals, 2012), proponents today increasingly settle for ‘cultured’ meat (Datar, 2016).

However, in this article, I argue that emphasizing instability risks overstating in vitro meat’s flexibility. Typical favourable rhetorics overlook the materiality of cultured meat, the conditions under which research and development (R&D) is undertaken and ongoing attempts to stabilize the meaning of ‘cultured’ or in vitro meat (cf. Stephens and Ruivenkamp, in press). To date, hundreds of articles depicting the tissue have surfaced, of which many are written by those with a clear stake in its proliferation: cultured meat researchers. Hence, in vitro meat becomes increasingly anchored to an influential set of publications making claims about what it is and what it could achieve. Important here is not only what is stated, a point to which I will return. As Foucault (1978) emphasizes, silence, the ‘things one declines to say’, is ‘an element that functions alongside the things said, with them and in relation to them within over-all strategies’ (p. 27). Silences permeating the promissory in vitro meat discourse speak about issues that proponents avoid exploring.

In relation to this dynamic, my account is an inquiry (and intervention) into how a new kind of meat is ‘enacted’ (Mol, 2002) at a time when proponents strive to establish a platform for its viability. Here, my story forms a continuation of work on constructions of potentiality (Taussig et al., 2013), expectations (Borup et al., 2006; Brown and Michael, 2003), hype (Brown, 2003; Sunder Rajan, 2006) and promises

(Fortun, 2008, 2012) in the life sciences, biomedicine and biotechnology. The meanings of such notions differ slightly, with ‘potentiality’, for example, more vague than ‘promise’, the latter implying a ‘wishful enactment of a desired future’ (Borup et al., 2006: 286) tied to actors promising (Taussig et al., 2013: S10). Scholars agree, however, that grasping future visions is crucial to understanding biotechnology.

Brown (2003), for example, argues that ‘hype and the noisy clamour of future projection are indispensably central to the shaping of technology’ (p. 5), while Sunder Rajan (2006: 34; see also Brown and Michael, 2003) describes biotechnology as a game ‘constantly played in the future in order to generate the present that enables that future’. Going further, Fortun (2012) argues that promises suffuse not only the life sciences but also all speech and even biological matter itself (which develops and, therefore, exists in a perpetually forward-looking state). Such intense focus on the future permeates in vitro meat discourse, which, in the absence of currently available products, by necessity centres on promising attractive scenarios.

The question, then, is how research should treat such an orientation to the future? For commentaries on genomics, Hedgecoe and Martin (2008: 819–820) speak of two ‘voices’ or ‘registers’, representing two styles of thinking. Whereas one situates genomics historically and questions its revolutionary nature, the other focuses on transformations. Hedgecoe and Martin (2008) argue that due to science and technology studies’ (STS) frequent focus on individual technologies, it prioritizes ‘the transformational theme at the expense of the contextual’ (p. 823). Research thereby comes to share ‘the dominant set of expectations promoted by innovators, which are claimed to signal a clear break with the past’ (p. 825). Such a focus in line with innovators’ expectations – centring on novel lifestyles, products and human–non-human animal relations – has arguably permeated most academic in vitro meat commentaries.

But in accounting for in vitro meat visions, I want to contextualize expectations and acknowledge them as ‘the outcome of struggles and contests between different voices each vying for control’ (Brown, 2003: 13). Innovators’ expectations could never be self-contained but instead clash with more dystopian or authenticity-thirsty discourses questioning the interventions that in vitro meat entails (cf. McHugh, 2010; Metcalf, 2013) and with a vegetarian or vegan discourse questioning the necessity of *any* meat (Fudge, 2010; Miller, 2012). In acknowledging such clashes, however, my goal is not simply to criticize in vitro meat (in relation to which my stance is one of

fascination rather than promotion or opposition). But foregrounding tensions is important for providing openings for further discussions of cultured meat beyond boosterist celebrations and quick dismissals.

Irreducible to but not apart from discursive clashes, my story also forms a continuation of accounts of ‘biocapital’ as a kind of capital emerging ‘when the substances and promises of biological materials, particularly stem cells and genomes, are increasingly inserted into projects of product-making and profit-seeking’ (Helmreich, 2008: 463– 464). Crucially, this entails *both* forms of wealth creation emerging ‘when laboratory instruments could be calibrated with market and legal instruments’ and beliefs in ‘biological process [as] already constitut[ing] a form of surplus value production’ (Helmreich, 2007: 288, 293). In Sunder Rajan’s (2006) words, biocapital thereby signifies ‘the implosion of an emergent economic regime with an emergent epistemic one’ (p. 142). This article thereby describes how a new kind of meat is presented against a background of how biological materials are increasingly manipulated to enable new products, and how the research for doing so is increasingly privately funded. As venture capital has become increasingly prevalent within in vitro meat R&D, this has accentuated the need for researchers to put on displays and to tell stories spectacular enough to attract such funding. As I will illustrate, venture capital has also shaped the research dynamics of the field in ways that potentially sit uneasily with the promissory discourse’s emphasis on altruism and collaboration.

My account is built on a close reading of how in vitro meat has been represented by proponents in peer-reviewed publications, by those developing in vitro meat products, and in other academic and science-journalist accounts, primarily between 2005 and 2015. Scrutinizing peer-reviewed publications and researchers’ presentations offers insights into how proponents articulate promises and define in vitro meat in order to place it in what Sunder Rajan (2006) has called biotechnology’s ‘messianic space, of technology and of Life linked through capital’ (p. 123). In tracing promissory discourse, this article covers the accounts of in vitro meat most heavily cited (according to Google Scholar). But my focus on how this new kind of meat is enacted means that I bracket articles originating from in vitro meat research that do not present products to readers (cf. du Puy et al., 2010; Roelen and Lopes, 2008). Moreover, by telling my story at a time when so much purchase is given to future scenarios, I am aware that I am myself contributing to making the future of the tissue: in offering new anchoring points I cannot escape engaging in attempts to stabilize in vitro meat.

On in vitro meat's history and in vitro meat discourse

As a 'world disclosing' technology, which 'occasion[s] particular political assemblies', 'demonstrate[s] new issue definitions' and 'give[s] rise to new moral subjects that emerge out of the struggles and debates' surrounding it (Driessen and Korthals, 2012: 803), in vitro meat provides a rather wonderful object to think with (cf. Turkle, 2007: 5). Herein, a long history of tissue engineering (Landecker, 2009) merges with current critiques of meat-eating's effects on human and non-human natures (Gerber et al., 2013; Steinfeld et al., 2006), art projects engaging with biotechnology in food (Catts and Zurr, 2014; Joachim and Tandon, 2014) and accounts of meat as what makes us human (cf. Engels, 2012: 178–179, Harris, 1998). Depictions unveil 'meat' as a symbolically laden category open to redefinitions (Fiddes, 1991; Mol and Yates-Doerr, 2012; Vialles, 1994; Yates-Doerr, 2015) and deem human behaviours changeable or natural. In vitro meat is thus already entwined in a vibrant discussion concerning what it is, albeit one where promissory discourse tends to repeat similar scenarios.

To date, in vitro meat-based futures have been depicted through projections of economic costs (Exmoor Pharma Concepts, 2008), environmental implications (Mattick et al., 2015a; Tuomisto et al., 2014; Tuomisto and Teixeira de Mattos, 2011), healthier lives enabled (Post, 2012; Van Eelen et al., 1999) and accounts of reshaped food production systems (Van Der Weele and Tramper, 2014). In contributing to such representations, researchers become, in Latour's (1996: 33) apt phrase 'sociotechnicians', actors simultaneously working on technological projects and defining their goals and questions. They, and commentators, become 'epistemic workers' (Castree, 2014: 22) whose statements make sense of in vitro meat. The first in vitro meat patent was issued in the Netherlands in 1999, applied for by Willem van Eelen (a medical doctor with a five-decade long interest in finding ways to produce meat in vitro), Willem van Kooten (a businessman and former pirate radio DJ) and Wiete Westerhof (a University of Amsterdam dermatologist). Leaving generous leeway for how to solve technological challenges and for the kind of meat produced, the idea was to extract intracellular embryo muscle cells or somite cells through a biopsy. A very fine scaffold (trabecula), preferably of an edible material, would be built up to allow muscle cells to grow in a medium 'refreshed as often as necessary, e.g. one or two times a week' (Van Eelen et al., 1999: 11). This process, the patent asserted, would 'render a product that is healthy and free of growth hormones at levels exceeding

physiological levels. The product can replace current meat products' (Van Eelen et al., 1999: 2). However, no product able to replace current meat products, nor any other edible product, immediately followed from this patent.

The first project generating in vitro-cultured tissue for *potential* human consumption instead surfaced in the United States, where the Food and Drug Administration (FDA) approved the National Aeronautics and Space Administration's (NASA) in vitro meat production techniques in 1995 (Joachim and Tandon, 2014). Chiming in with NASA's ambition to deliver not only nutrition but food-derived 'psychological rewards' (Belasco, 2006: 233) to astronauts, in 2000 researchers cultivated goldfish (*Carassius Auratus*) adult dorsal abdominal skeletal muscle mass (Benjaminson et al., 2002), viewing in situ produced food as a way to ensure the day-to-day morale on a long-haul Mars mission.

Using skeletal muscle explants 'not only composed of muscle fibers, but also contain[ing] all the cell types generally associated with muscle in *vivo*' (Benjaminson et al., 2002: 880, emphasis in original) cultured in foetal bovine serum, Shiitake, fish meal and Maitake cultures, the researchers achieved surface area growth rates between 4.8 percent (with Shiitake) and 15.6 percent (with Maitake). Although never eaten, 'fish filets' derived from foetal bovine serum experiments were 'marinated for 1 min in extra virgin olive oil, chopped garlic, lemon, and pepper ... covered in plain breadcrumbs and then deep-fried until golden brown' (p. 883). These were thereafter presented to a four-person 'odor and appearance panel'.

The first cultured muscle cells meat *eaten* was instead produced by artists. In 2003, Oron Catts and Ionat Zurr (2008, 2013) served in vitro frog 'steaks', produced at a cost of approximately US\$650/g, at the exhibition *L'Art Biotech* in Nantes. In so doing, Catts and Zurr (2014) wanted to poke 'fun at French taste and their resentment towards engineered food, and the objection by other cultures of the consumption of frogs as food' (p. 22).

The burger sparking so much attention in 2013 was hence neither the first in vitro meat produced nor the first eaten. But through this burger's spectacular unveiling, in vitro meat became well known also among many without a burning interest in meat debates and/or futuristic technologies. This burger marked the culmination of a project initiated in 2009, led by Mark Post (Maastricht University, 2013b). In turn, this research had been built on a 2005–2009 state-funded Dutch study, in which a national in vitro consortium was put together, consisting of Willem van Eelen (representing the

company VitroMeat BV); the Faculty of Biomedical Technology (Technical University Eindhoven); the Swammerdam Institute of Life Sciences (University of Amsterdam); the Faculty of Veterinary Medicine (Utrecht University); and, as an industrial partner, the meat producer Meester Stegeman (Haagsman et al., 2009). To produce the burger, Post's team cultured myosatellite cells, stem cells only able to become muscle cells (Maastricht University, 2013b). This technology thus differed considerably from, for example, Benjaminson et al.'s use of explants (i.e. muscle pieces). Culturing the muscle cells used in the burger took a mere 3 months (much less than rearing meat conventionally would) but was prohibitively expensive for commercial application. Producing a patty reportedly cost €250,000 (US\$330,000), funded by Google co-founder Sergey Brin (Jha, 2013). More than a technological breakthrough, however, the burger signalled a 'proof of concept to the public' (Post, 2014a: 1040). This explicit search for attention should, according to the head of the production team, be understood in light of how the Dutch government did not extend funding for the national in vitro meat consortium because researchers 'failed to generate sufficient interest from the private sector and the public' (Post, 2014a: 1040). Here, private funding's influence on how research is conducted and presented begins to become apparent.

Alongside university researchers, investors and artists, in vitro meat's early history was especially shaped also by two high-profile non-governmental organizations (NGOs): People for the Ethical Treatment of Animals (PETA) and New Harvest, an organization that presents itself as 'accelerating breakthroughs in cellular agriculture'. PETA provided funding for biological engineer Nicholas Genovese's and tissue researcher Vladimir Mironov's meat-culturing attempts at the Medical University of South Carolina (Specter, 2011) and in 2008 launched a campaign promising US\$1 million 'for the first laboratory to use chicken cells to create commercially viable in vitro (test tube) meat' (PETA, 2014). However, no laboratory claimed this prize by the competition's March 2014 deadline (in turn pushed back from an earlier deadline passed without any contestants applying).

At New Harvest, both the organization's founder Jason Matheny and current Executive Director Isha Datar have co-authored influential academic publications on in vitro meat (Datar and Betti, 2010; Edelman et al., 2005). The organization's description of its 2015 activities aptly illustrates their current involvement. In that year, it gave US\$50,000 to research on in vitro meat made without animal serum at

Maastricht University and co-hosted an international symposium on cultured meat in the same city. New Harvest also gave US\$53,000 to research on ‘making a 3D vascularized tissue (a steak)’ at King’s College London and brought together Memphis Meats’ team (initially researching *in vitro* pork). It was simultaneously involved in launching a Tufts University fellowship programme for students working on tissue-engineered foods (New Harvest, 2015).

New Harvest’s current activities also illustrate the aforementioned shift from public to private funding of *in vitro* meat R&D, a shift that accentuates the relevance of reading promissory *in vitro* meat discourse in relation to biocapital. The fish filets project acquired state funding, as did early Dutch research. The 2013 burger was instead made possible by private investments, while New Harvest-channelled donations have enabled later projects. In 2014, Li Ka-shing’s Horizons Ventures invested a reported US\$10 million in cultured meat and leather researchers Modern Meadow. Meanwhile, Post’s current strategy is to get *in vitro* meat to market within 5 years through the company Mosa Meat.

The emergence of an *in vitro* meat canon

When *in vitro* meat surfaced as an actually existing (if embryonic) food production technology, it came entangled with more than a century of science fiction accounts, political visions and research dreams portraying a world where beasts could be bypassed and meat cultured directly from cells. To centre on these, I now shift to the story of *in vitro* meat as a story about meat in relation to human and non-human natures, a story about technological developments’ roles in shaping future visions, and a story about the actors who have become the faces for *in vitro* meat. Here, promissory statements’ role in making a desirable future present becomes remarked. But this is also where promissory claims clash with more dystopian or more meat-averse discourses.

By heading the team producing the first *in vitro* meat burger, Mark Post has become perhaps the most immediately recognizable face of *in vitro* meat, a tendency strengthened by press images released for the tasting event. Depicting a smartly dressed Post smiling to the camera while holding a burger, the story of *in vitro* meat easily turns into the story of ‘his’ burger (Figure 1).



Figure 1. Professor Mark Post with a burger made from cultured beef (photograph by David Parry/PA Wire).

But alongside Post, several others form a nascent *in vitro* meat canon, where a quote from a 1931 Winston Churchill piece is repeated with incredible frequency. ‘Fifty years hence’, the future UK Prime minister wrote, ‘[w]e shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium’ (Churchill, 1931). In repeating this quote, promissory discourse anchors *in vitro* meat to a politician who was one of the defining faces of 20th-century politics, a symbol of Britain emerging victorious from World War II (WWII), and voted ‘greatest Briton’ ever in a 2002 poll (BBC, 2002).

Besides transcending animals, Churchill’s (1931) vision was, importantly, also about freeing up land:

If the gigantic new sources of power become available, food will be produced without recourse to sunlight. Vast cellars in which artificial radiation is generated may replace the cornfields or potato-patches of the world. Parks and gardens will cover our pastures and ploughed fields. When the time comes there will be plenty of room for the cities to spread themselves again.

New foods, Churchill fully acknowledged, would mean new socio-spatial relations. This is a point to which I will return.

The fact that Churchill chose chicken as the disassembled animal illustrating his vision might be significant. Although chicken has since become the epitome of cheap

meat, it has in some times and places been less affordable. When Herbert Hoover in his 1928 presidential campaign promised a chicken in every pot, Americans consumed on average 5 lbs chicken per year, while chicken around 1900 was more expensive than beef or lobster (Boyd and Watts, 1997). Promising chicken was, therefore, not promising yet more of a kind of meat already abundant, but promising access to a kind of meat somewhat inaccessible. Chicken was simultaneously at the centre of one the early 20th century's most famous medical experiments, Alexis Carrel's (1912, 1914) attempt to achieve 'permanent life' for a piece of chicken heart tissue. Explicitly marshalled as an inspiration by Benjaminson et al. (2002: 881), this 34-year attempt to keep tissue alive was, although its findings have long since been refuted, an immensely influential inspiration regarding just how much 'life' could be tampered with and how tissues could stay alive for prolonged periods outside bodies (Landecker, 2009).

In addition, the personal biographies of those contributing to early in vitro meat R&D are continuously invoked as an in vitro meat canon takes shape. We learn, for example, of Willem van Eelen's time imprisoned and starving in WWII Japanese prisoner-of-war camps and how this led to an interest in in vitro meat development (Maastricht University, 2013b; Specter, 2011). In accounts of his life, Carrel's chicken, or Churchill's dream of efficient food production, accounts of past processes begin to fill the 'ontological void' Van Der Weele and Driessen (2013) claim characterizes in vitro meat's future. Present developments and future visions become anchored to previous hopes, fates and aspirations. In such uses of the past, actors simultaneously recontextualize and incorporate other practices into their own (Fairclough, 2013: 264). Carrel's work now becomes seen as a precursor to current food production experiments, and what was essentially a failed experiment (chicken tissue cannot be held alive for nearly as long as Carrel suggested) is rendered inspirational.

Often repeated, and potentially unsettling the promissory discourse, are, however, some bleak science fiction scenarios. German writer and scientist Kurd Lasswitz provided the first mention of cultured meat in his 1897 novel *Auf Zwei Planeten* (*Two Planets*) (Ford, 2011). More prevalent are accounts anchoring in vitro meat to later science fiction, most notably Margaret Atwood's *Oryx and Crake*. In the future she describes, monstrous genetically modified animals roam the world, while artificial or in vitro meat form most humans' diets. Here, a more dystopian discourse surfaces, with Atwood inspiring account's questioning the desirability of the technological interventions that cultured meat production entails and the authenticity of the resulting

products (cf. McHugh, 2010; Parry, 2009; Sanderson, 2013). And indeed, questions concerning whether in vitro meat will ‘separate us from nature’ (Welin and Van Der Weele, 2012; see also Van Der Weele and Tramper, 2014) have surfaced even in the promissory discourse, although Welin and van der Weele answer this question in the negative.

In vitro meat, as continuity and contrast

Although in vitro meat is presented as radically new, historical anchoring points, such as those described above, ensure that a continuous story is established. At the same time, echoing a long-standing trend of removing animal bodies from the dinner table (Elias, 1978), cultured meat also signify to some a continuation of how animal agriculture has transformed animal bodies (cf. Boyd, 2001; Ritvo, 1987). As Driessen and Korthals (2012) remark,

Pigs and broiler chickens in particular are being equipped with ever-improved conversion factors for efficiently turning feed into meat, as the animals are designed to invest less energy in superfluous behaviours and bodily features. In this trajectory, a technology that takes this development in agricultural production to its logical conclusion would be meat production without animals. (p. 802)

Here, in vitro meat production merely signals the latest stage in a cumulative reshaping of animals to more efficiently turn feed into meat. Proponents often present in vitro meat as just such ‘logical conclusion’, built on what research has uncovered about nonhuman animals and tissue culturing and on certain presuppositions about human dietary preferences.

These representations rest on two pillars. On the one hand, conventional meat is repeatedly framed as unsustainable. With an increasing and increasingly wealthy global population, the argument goes, meat consumption is reaching levels the earth cannot handle. The other pillar, thereafter, asserts the necessity of *some* kind of meat. Meat, in vitro meat proponents argue, is inescapably desirable. For space voyages, Benjaminson et al. (2002) were, for example, doubtful

...that the human crew will be satisfied or satiated by a strict vegetarian diet supplied by controlled ecological life support systems (CELSS). Maintenance of crew morale is, however, vital for the success of a mission and a supply of fresh animal muscle protein will help foster this. (p. 879)

Meat, in other words, is not merely regarded as a way to provide nutrition but as a treat to maintain crew morale. Press material for the 2013 in vitro burger takes such desire for meat further, incorporating everybody:

Humans as a race have shown no sign of wishing to eat less meat, so it is unrealistic to think about eradicating meat from the human diet in the future. A sustainable way of providing it has to be found. If people are to continue to eat meat, and are not satisfied by vegetable substitutes, a way of producing Cultured Beef has to be found. (Maastricht University, 2013b: 3)

In response to these challenges, the promissory discourse presents cultured meat as meat, nothing more, nothing less. As Tuomisto and Teixeira de Mattos (2011) write in an influential account of in vitro meat's environmental impacts, 'cultured meat consists of similar muscle tissue [as] conventionally produced meat, [and] only the production technique differs' (p. 6122). A presentation of the 2013 in vitro burger similarly assured its audience that '[w]hen all these little pieces of muscle are layered together we get exactly the same thing we started with[,] beef' (Cultured Beef, 2013b).

But defining in vitro meat as 'meat' simultaneously risks running up against the European Union's (2004) definition of meat as the edible parts of domestic ungulates, poultry, lagomorphs, wild game and farmed game or the US FDA's (2009) definition of meat as the 'flesh of animals used as food including the dressed flesh of cattle, swine, sheep, or goats and other edible animals, except fish, poultry, and wild game animals'. Framing in vitro meat as meat, plain and simple, furthermore reifies meat as object, whereas prominent in vitro meat promises seem more about chiselling out new meat *relations*. If the production process differs, as Tuomisto and Teixeira de Mattos (2011) acknowledge, the end result must differ – since the relations that production

internalizes are not the same (cf. Ollman, 2003: 13). As Landecker (2016) aptly puts this point, a cell culture ‘is what it eats’.

Similarly, although proponents and developers promise that *in vitro* meat is just meat, they nonetheless grant it transformative power. Van Der Weele and Driessen (2013), for example, claim that *in vitro* meat stimulates both new design activities and new moral considerations. Noting that depictions frequently show an ordinary piece of meat with an *in vitro* element added, ‘a steak in an Erlenmeyer flask’, they are adamant that such an add-on transforms everything:

[T]his ‘*in vitro*’ component turns cultured meat into something completely different in many and confusing ways: Something that is potentially good for animals, something unnatural, something scary, something to counter climate change and pollution. (Van Der Weele and Driessen, 2013: 651)

The depiction is thus of something recognizable (mere meat) with an extraordinary capacity to recontextualize meat and meat-eating alike.

In depicting a world built on such products, the promissory discourse echoes earlier remarks concerning tissue engineering and cell culturing. A leitmotif of Landecker’s (2009) history of tissue culturing’s *medical* research applications is how new technological developments opened up a new sense of possibility. Cells, Landecker describes, were throughout the 20th century less and less regarded as fettered to human or nonhuman bodies and instead increasingly regarded as plastic technologies. Part of this was a marvel at the sheer mass of especially the HeLa cell strain; a strain of cancerous cells taken from a 1951 biopsy conducted on Henrietta Lacks and thereafter cultured in ever larger volumes. Divided over cell cultures all over the world, biopsy-derived cells eventually weighed more than the patient ever did (Landecker, 2009). As Landecker (2009) remarks, this ‘stands as one form of realization of a transition in possibility for human matter: There can be more life in its technological form than in its original, bounded, mortal container’ (p. 179).

The same fascination with how much ‘life’ can be produced once the ‘original, bounded, mortal container’ is abandoned is repeated in representations of tissue culturing’s current food applications. A fleshy cornucopia of endless meat supply is evoked through depictions of how a single biopsy could theoretically feed the world. This theme was present already in the first peer-reviewed publication on *in vitro* meat,

where Edelman et al. (2005) commented that ‘back-of-the-envelope calculations suggest that a single parent cell with a Hayflick limit [the total number of cell divisions possible before divisions stop] of 75 could theoretically satisfy the current annual global demand for meat’ (p. 660). Likewise, Maastricht University (2013b: 3) in their presentation of the in vitro burger states that it ‘is estimated one single sample could produce 20,000 tonnes of Cultured Beef, enough to make more than 175 million quarter-pounder patties. This many patties would otherwise require meat from more than 440,000 cows.’

Such sense of an infinite meat supply simultaneously refashions how specific animals’ meat is regarded. In future scenarios, in vitro meat opens up the possibility of eating the flesh of exotic, endangered, animals (Coghlan, 2011; Welin, 2013) or (although this should be read more as a tongue-in-cheek remark) of indulging in victimless cannibalism (Mattick and Allenby, 2012). This signals a radically refashioned relation between meat-eater and the (potentially still living) animal eaten. Similar spectacular visions are expressed also by those at the very epicentre of in vitro meat development. Post (2012) has, for example, commented that ‘stem cells from probably every mammalian source or blends of cell sources can be used as a basis for *hitherto unimaginable meats*’ (p. 298, emphasis added; see also Post, 2014b; Van Eelen et al., 1999: 5).

While ‘meat’ has usually (but not always exclusively) meant muscles appropriated from animals who needed them to stay alive (Fiddes, 1991), it would now include substances grown directly for human consumption, with new desirable properties built into them. The possibility of re -designing meat was included already in the first in vitro meat patent (Van Eelen et al., 1999), and Post (2012) comments that ‘the biochemical composition of meat might be changed to make it a healthier or specialized diet product, for example by increasing the content of poly-unsaturated fatty acids’ (p. 299).

While these passages exemplify a wish to reshape meat, the benefits of meat (as such) provide a background for arguments for cultured meat. As Bhat and Fayaz (2011; see also Datar and Betti, 2010: 14) comment,

Humans are taxonomically omnivorous and meat provides several essential nutrients unavailable in plant sources. Meat is specifically valuable

as a source of omega-3 fatty acids, vitamin B12, protein and highly bioavailable iron. (p. 125)

But this passage perhaps says more about promissory rhetoric than about in vitro meat products' probable properties. As Jones (2010) remarks, both iron, which comes from blood, and vitamin B12, which comes from gut bacteria, would have to be added to cultured meat. Neither are omega-3 fatty acids, the result of livestock consuming grass containing such acids, inherent to muscle cells (Duckett et al., 1993). Releasing meat from an animal body removes meat from the relations lending it its nutritional composition, from the system that keeps cells proliferating and from the immune system shielding meat tissue. In rhetorically reifying meat to claim that there is nothing unnatural about in vitro meat, proponents risk overlooking how meat's nutritional properties result from relations internalized. In neglecting this, promissory discourse neglects technological challenges facing in vitro meat production.

The vision is, moreover, not merely that in vitro meat should enable a harmonious relation between the human body and non-human animals but also to provide a way of producing meat without livestock industries' current environmental impact. The most influential early evaluation of in vitro meat's environmental implications was conducted by Tuomisto and Teixeira de Mattos (2011). They estimated that in vitro meat could involve lower energy use than beef, pork or sheep production (but higher than poultry), that water use levels and greenhouse gas emissions could be lowered significantly and that in vitro meat production could potentially involve a 99 percent reduction in land use compared with conventionally produced meat. Questions concerning desirable land uses thus resurface.

From Churchill's (1931) dream of parks and gardens supplanting pastures and ploughed fields to Van Der Weele and Trampler's (2014: 294) vision of villages where 'pigs live happy lives as companion animals while their cells are cultured in local meat factories', hopes for new food production systems are also hopes for new socio-spatial configurations. For in vitro meat, this dream entails radically repartitioning land at a rather astonishing scale. As Tuomisto (2010) argues, land released from livestock production and agriculture as a result of a turn towards cultured meat could be used both for bioenergy production and wildlife conservation (see also Welin and Van Der Weele, 2012). But as Welin (2013: 33) remarks, present-day meat-processing industries might (unsurprisingly) have a problem with such a development. Urban production of

cultured meat ‘may even be seen as a serious threat to a living countryside and could trigger popular protest’ (Welin, 2013: 33).

These examples make evident how little the promissory discourse can claim that in vitro meat is *actually* just like any other meat. Promissory depictions rather assert that in vitro meat is similar enough to conventional meat to offer the same nutrition or morale boost. But it is simultaneously deemed different from muscle-derived meat in the relationships it allows (and ends) with non-human animals, in being healthier and in being better for the environment. Here lies a tension between assuring similarity and asserting difference that remains underexplored in the promissory discourse.

Post has recently remarked that if ‘there are sufficient steps between the animal and the eventual product, and if they’re all under the approval of a rabbi then [cultured pork] could be declared kosher’ (Post, cited in Cadwalladr, 2014). Similarly, Bhat and Fayaz (2011) comment that in vitro meat minimizes religious taboos such as Jhatka and Halal. For proponents and developers, in vitro meat, in other words, could create a world where Jews and Muslims could eat new meat products and where, as Swyngedouw (2010) puts it, vegetarians might be tempted ‘to return to the flock of animal protein devotees’ (p. 185).

Yet such a spirit of indulgence seems more complicated than promissory assurances usually acknowledge. Rather than creating a feeling of ‘missing out’, religious dietary dictates are often regarded as freeing people from blind instincts and enabling them to express their devotion (Regenstein et al., 2003). There is, furthermore, not *a* Jewish position on cultured meat but instead a debate on potential products’ position (cf. Gross, 2014; Sokol, 2013). Some scholars consider cultured beef *pareve*, neither meat nor milk (Gross, 2014). On such a view, tissues would occupy a position akin to gelatine, signaling the ‘birth of the kosher cheeseburger’ (Sokol, 2013). But discussions simultaneously revolve around whether previous accounts of meat delivered from heaven offer any guidance, and (if cultured meat is construed as meat rather than *pareve*) whether eating it would violate biblical prohibitions against eating meat severed from a living animal (Sokol, 2013). Positioning in vitro meat as kosher hence risks running against either of two central in vitro meat promises. Either it is not meat but *pareve* or, with meat from animals still alive potentially violating biblical prohibitions, it cannot be produced without slaughtering animals.

Similarly, although in vitro meat has the capacity to radically reorder how meat is regarded among vegans and animal rights activists, a favourable reception among

these has been far from unanimous. While the well-known animal liberation philosopher Peter Singer (2013) welcomed the 2013 burger as ‘cruelty-free’, Miller (2012) instead argues that in vitro meat ‘serves only to inscribe vegetarianism in the worldview it contests’ (p. 60). Although in vitro meat might open up possibilities for groups (vegans, vegetarians, Jews, Hindus, Muslims, etc.) that previously have restricted their diets, there is certainly no guarantee that all welcome such possibilities. To some, in vitro meat rather ‘reveals our unwillingness to give up one of the things that makes us who it is that we think we are’ (Fudge, 2010: 161) and ‘tacitly affirm[s] the cultural centrality of meat’ (Miller, 2012: 44).

Relative silences in promissory depictions

The passages above stress how the promissory discourse enacts ‘cultured’ (Datar, 2016) or in vitro meat. In vitro meat is meat, and meat is nutritional, necessary and a morale booster. But through their silences proponents also delimit what in vitro meat is not. It is *not* synthetic, artificial, laboratory meat, vat meat or a meat substitute. Hence, proponents attempt a kind of strategic multiplication of meat as category (cf. Mol and Yates-Doerr, 2012). ‘Meat’ is now to include cultured cells besides muscle (cf. Fiddes, 1991). But the category is not opened up to also include, for instance, soy products as meat (Yates-Doerr, 2015) or to, as meat once did in some languages, refer to all kinds of food (Vialles, 1994).

And while the last section ended with the hopes and tensions sparked when in vitro meat is depicted as a ‘cruelty-free’ (Singer, 2013) tissue welcoming previously excluded groups into the meat-eating community, what ‘cruelty-free’ denotes varies between accounts. In answering whether in vitro meat would involve ‘cruelty to animals’, press material issued concomitantly with the 2013 burger underscores the painlessness of the biopsy (see also Hopkins and Dacey, 2008: 592):

We still need donor animals for the muscle cells, but the animals can provide the cells by harmless biopsy. One sample could create up to 20,000 tons of Cultured Beef. You can take a sample from an animal and the animal lives. (Maastricht University, 2013a: 2)

Others choose starting points harder to reconcile with in vitro meat as promising cruelty-free meat.

Although Catts and Zurr (2008) have toyed with the *idea* of victimlessness, and been approached by PETA to collaborate on producing ‘victimless meat’, they simultaneously accentuate what they call the ‘hidden victims of tissue culture’ (p. 131). Thereby, they underscore three complications arising from framing in vitro meat as victimless (see also McHugh, 2010):

First, in order to grow in vitro meat, there is still the need for a serum created using animals’ blood plasma. Although there is some research to find alternatives for this ingredient there is no solution in near sight and animals (mainly calves or fetal bovine) are sacrificed for that ingredient. Second, all the ‘costs’ concerned with the running of a laboratory, i.e. fossil fuels burned, greenhouse gases produces [sic.], water and trees consumed, miles traveled and the waste created. Third, there is a shift from ‘the red in tooth and claw’ of nature to a mediated nature. The victims are pushed farther away; they still exist, but are much more implicit. Hence, the animal is abstracted into fragments and mediated through technological apparatuses. (Catts and Zurr, 2013: 107)

Problematizing ‘victimlessness’ here leads to foregrounding erstwhile silences. Elsewhere, the artists have estimated that growing 10 g of tissue would require ‘serum from a whole calf (500 mL), which is killed solely for the purpose of producing the serum’ (Catts and Zurr, 2008: 133). Hence, Catts and Zurr illuminate how transcending the animal body does not mean escaping the necessity of mimicking processes living tissues need. In vitro meat production has to date supplanted a bovine, ovine or porcine body with a technological one, as serum supply systems supplant blood vessels and sterile laboratory conditions supplant white blood cells. As Mattick et al. (2015a) comment, what was previously the result of ‘internal biological functions (temperature regulation, digestion, oxygenation, nutrient distribution, disease prevention, etc.) fueled by agricultural energy inputs (feed)’ (p. 11946) must thus be performed by industrial energy. Hence, in vitro meat remains inseparable from not only the laboratory but also from laboratory ‘hinterlands’ providing foetal bovine serum and so on. Although there are visions for supplanting animal-derived serums with animal-free

solutions (Post, 2012, 2014a; Van Der Weele and Tramper, 2014), such a shift would not lessen the analytical importance of acknowledging extra-laboratory relations. Rather, new solutions would ‘merely’ change the particular environments co-produced with cultured meat.

While promissory depictions emphasize the land saved, they (often between the lines) simultaneously depict future scenarios where segments of the earth are reordered to mirror the requirements of *in vitro* meat production. Tuomisto and Teixeira de Mattos’ (2011) environmental analysis, for example, based evaluations on a hypothetical cyanobacteria-based nutrient and energy source, with equally hypothetical production sites in Thailand, California and Spain. In an update, Tuomisto et al. (2014) instead assessed plant-based nutrient media in a novel kind of hollow fibre bioreactor. Production was now hypothesized for Spain¹.

Bhat and Fayaz (2011), on their side, outlined the Pall Corporation’s Ultraser™ serum substitute, a Maitake mushroom extract of the kind that Benjaminson et al. (2002) used, and lipids as hypothetical future bases for cell-culturing media. They thereby outline three different *in vitro* meat geographies. A production system built up around an already commercially available serum substitute differs from a production system built on Maitake landscapes. In accentuating *in vitro* meat as internalizing relations stretching far beyond laboratories, such scenarios undermine those depictions of *in vitro* meat radically simplifying the production process. Figure 2 exemplifies a frequently repeated ‘closed’ depiction of *in vitro* meat production as a system of beakers, cells, donor animals and end products (see also Bhat and Fayaz, 2011: 127; Haagsman et al., 2009: 6; Post, 2014a: 1039). While iron, vitamin B12 or flows of nutrients are not necessarily eliminated from these depictions (see step 7 in Figure 2), they are nonetheless assigned a position of secondary importance. They enter from the (out)sides in linear depictions of the route from cell biopsy to burger or frankfurter.

But perhaps most importantly in an article tying *in vitro* meat to conceptualizations of biocapital and privately funded science, this depiction, and others like it, omit investments. They thereby omit a key element among the processes

¹ Tuomisto and Teixeira de Mattos’ (2011) life cycle assessment (LCA) has been challenged by others. Based on established, rather than hypothetical cell culture techniques, Mattick et al. (2015a: 11945) estimate that ‘due mostly to the inclusion of basal media production and the cleaning phase’, *in vitro* meat’s energy consumption and global warming potential are approximately three times prior estimates. Simultaneously, land-use requirements are ‘roughly 20 times those of the previous LCA due to the use of a different feedstock and additional culture inputs, such as basal media and soy hydrolysate’. In another recent account, Mattick et al. (2015b) argue that acknowledging livestock products, from soap to pet food via vaccines and therapeutic hormones, further problematizes evaluations of *in vitro* meat’s impacts.

constituting in vitro meat. Flows of capital are crucial to the existence of many life forms today (Harvey, 1998), and cultured meat is (as €250,000 for an 85-g hamburger underscores) an immensely capital-intensive nature. Yet, with some important exceptions (McHugh, 2010; Miller, 2012; Pluhar, 2010), political economy remains almost fully excluded from the story of this tissue. As Miller (2012) sarcastically remarks, cultured meat rather ‘constitutes an aspect of a benevolent technotopia in which the world’s finest minds work altruistically for the general good, as neo-liberal capitalism is brought suddenly, miraculously even, into alignment with careful ethical thinking’ (p. 49). Here, promissory in vitro meat discourse repeats a well-rehearsed story of innovators delivering biocapitalistic salvation (Sunder Rajan, 2006).

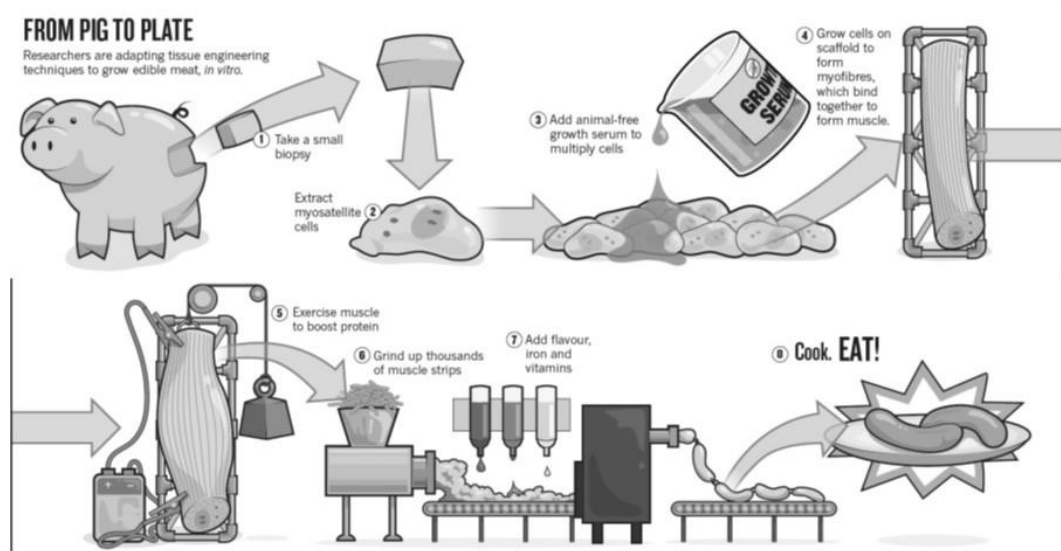


Figure 2. ‘From pig to plate’. Illustration by Nik Spencer. Reprinted by permission from Macmillan Publishers Ltd: Nature. (Jones, 2010), copyright 2016.

In promising this, perhaps the most astonishing novel relation offered through in vitro meat is a turn to altruistic R&D. To illustrate: In its preliminary economic study of in vitro meat production, Exmoor Pharma Concepts (2008) chooses to neglect admitted significant R&D costs, assuming that these ‘will be met by governments and by charitable donations and that the resulting technology would then be made freely available’ (p. 3). Emphasizing knowledge as freely shared, Exmoor Pharma Concepts thereby paints a picture of R&D freed from the ‘insistence on the commercialization and privatization of knowledge [that] has created substantive shifts in the organization and practice of science’ (Lave et al., 2010: 665). Such a depiction of shared results contrasts remarkably with how the political economy of biotechnology has been

construed elsewhere (cf. Sunder Rajan, 2012). As Evans (2010) remarks, ‘by enrolling companies in their research, scientists appear less able to enroll other academics’ (p. 779). Industry collaboration can thereby result in the opposite of Exmoor Pharma Concepts’ assumption, as seen in at least some prominent *in vitro* meat research environments. Sergey Brin’s funding for the 2013 burger, for instance, ‘mandated that Post and his team work alone’ (Post, 2014b: 48).

Although Latour’s (1996) presentation of ‘sociotechnicians’ easily lends itself to a reading of innovators themselves defining which goals and questions to pursue, the 2013 burger thereby illustrates how *in vitro* meat researchers are never free from discursive and political-economic ties that render certain questions and goals more pursuable. Post’s (2014a) ‘public proof of concept’ exemplifies just how entangled research goals can be in processes over which a single researcher often has little influence. Attracting attention was hardly Post’s own primary research goal. But it was a requirement to secure funding or, in other words, a result of a ‘tyranny of relevance’ prioritizing ‘knowledge produced to meet market needs’ (Lave, 2012: 23). With sudden venture capital injections and donations supplanting a more steady trickle of public funding, researchers’ ability to depict desirable futures becomes accentuated (see also Lave et al., 2010: 665). Deeming meat inescapable is then not only a claim about what humans require but also an argument for *in vitro* meat’s commercial viability. Claiming cornucopia and promising a desirable mix of similarity and difference in relation to conventional meat products are selling points.

In this light, it is surprising that writings on *in vitro* meat contain so few mentions of political-economic processes. This silence becomes a constitutive component of promissory discourse (cf. Foucault, 1978). Neglected are also the future working conditions of *in vitro* meat production. In the promissory discourse, conventional meat production’s labour relations occasionally surface as part of the critique of today’s meat (cf. Cole and Morgan, 2013: 210; Pluhar, 2010). But little is so far said about *in vitro* meat production’s intended labour relations (but see Welin, 2013; Van Der Weele and Tramper, 2014). Like the role of cheapened labour in the turn towards cheaper food at large (Guthman, 2011), the (still hypothetical) role of cheapened labour in cheapening cultured meat gets short shrift. Depictions of an *in vitro* meat-based future thus entail an asymmetry where the production process as structured today is paired with hypothetical future technologies. Highly trained researchers assembling burgers (the current situation) are accompanied by a

hypothetical future scenario built on supplanting current animal-derived serums with animal-free nutrient solutions. But if current industrial-scale food production systems are anything to go by, it seems certain that in vitro meat production would have to change significantly for it to be feasible as a food production technology for staple proteins. The labour challenges surrounding such a transformation are typically invisible.

Conclusion

'I am eating misery', Alice Walker (1988: 8) once stated concerning her meat-eating, thus provocatively illustrating how eating involves entangling oneself in other lives. But with meat produced from 'life in its technological form' (Landecker, 2009: 179), we could, cultured meat proponents argue, eventually eat something far less controversial: cruelty-free meat produced under safe, sanitary, land-saving and sustainable laboratory conditions. But to return to the questions with which I began my inquiry, what is in vitro meat, and what does it offer? The first cultured beef burger consisted of 10,000 minuscule muscle strands bundled together. But this burger simultaneously bundled together future visions, attitudes towards meat, labour processes and hegemonic problem definitions. Some such ingredients are out in the open for everyone to see, deliberately communicated by researchers and proponents of cultured meat. Others are more hidden, in need of being dug up and fleshed out.

The role of the promissory discourse is precisely such selective future-making, to repeat particular expectations and thereby reshape the possibilities for in vitro meat R&D today. The struggle for discursive stability is here a struggle to secure funding for a kind of research entangling universities, capital and publics excited about cultured meat. Here, in vitro meat's future seems less an 'ontological void' (Van Der Weele and Driessen, 2013) than a sphere colonized by influential depictions (cf. Adam and Groves, 2007: 13).

In terms of why a set of promissory accounts has become so prevalent, I think we could justifiably point to three interrelated reasons. First, promissory in vitro meat discourse mirrors the centrality of expectations and promises in biotechnology (cf. Borup et al., 2006; Brown and Michael, 2003; Sunder Rajan, 2006). Cultured meat proponents are aware of this and act accordingly. Isha Datar and Robert Bolton (2014),

for instance, argue that the ‘new science of carniculture must be developed responsibly, driven by discourse from the beginning’ (p. 159). Second, the promissory discourse sits well with a story of biotechnological salvation (Sunder Rajan, 2006) and with a long-standing (if certainly not uncontested) belief in futuristic technologies as food production solutions (Belasco, 2006). And third, the promissory discourse fits privatized science’s ‘tyranny of relevance’ (Lave, 2012). In vitro meat is enacted so as to be savoury to investors. Not only is an ontological void filled, but it is filled in a way that situates in vitro meat as an eventually viable product. Spectacular statements underscoring cultured meat’s transformative power are symptomatic for a period where a shift to private funding renders boosterist speculations profitable and rational, even indispensable (Cooper, 2008; Sunder Rajan, 2006).

Here also, the rationale for what the promissory discourse occludes becomes evident. To engage with debates on meat and *pareve* unsettles assurances that in vitro meat is just meat. To emphasize foetal bovine serum unsettles depictions of in vitro meat as a universally desirable commodity-to-be. Centring on future labour relations undermines depictions of in vitro meat as a new, clean, biotechnological salvation. In vitro meat should here signal a clear break with Churchill’s absurdity, with van Eelen’s starvation and livestock as environmental problem. But such promises are articulated at the expense of an emphasis on understandings of meat as cumulative enactments where meat is (re)made in relation to established regulations and meanings. In this cumulative process, no set of statements and no discourse reigns supreme. Instead, the promissory discourse is potentially threatened by those unimpressed by the prospect of in vitro meat.

In directing attention to such tensions, my objective is not to deliver a verdict on whether ‘cultured’ or ‘in vitro’ meat is desirable. But I do want to create preconditions for further explorations of the world(s) this tissue could produce and the world it is produced by. While it remains impossible to determine what would happen if in vitro meat became adopted at an industrial scale, it *is* possible to state that in order to understand this tissue, emphasis could productively shift from boosterist claims to also acknowledge those claims more marginalized in the promissory discourse. The relatively uncharted territories left behind by symptomatic silences disclose crucial relations that in vitro-produced tissues could internalize (Ollman, 2003).

As flagged above, my story of cultured meat continues earlier work on biotechnology and biocapital, including its attention to future visions and biotechnological hype. Notable is the shift towards venture capital-fuelled science. A focus on high-profile products and ‘proof[s] of concept’ accentuates how activist-channelled donations and venture capital shape research and rhetoric alike.

Biotechnology and biocapital today build on biology as a discipline or discourse emphasizing multi-scalar, multi-species interdependencies. Here, the promissory discourse on ‘cultured’ or ‘in vitro’ meat offers an apt example of how a biotech-imperative.

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