

# In Vitro Meat and Science Fiction

## Contemporary Narratives of Cultured Flesh

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This article argues that the in vitro (i.e., lab-grown) meat boom can be better understood by framing it within sf studies, both historically and especially through to the contemporary moment. Not only does in vitro meat (IVM) have a long history of representation in sf, it is also framed in the public and corporate spheres through the use of sf tropes. The article offers close readings of IVM in Margaret Atwood's *Oryx and Crake* (2003), Elizabeth Dougherty's *The Blind Pig* (2010), and director Brandon Cronenberg's *Antiviral* (2012), arguing that reading IVM in contemporary sf is a particularly effective method of thinking through its material effects.

“We 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.”

—“Fifty Years Hence,” Winston Churchill (1931)

“‘What the hell is it?’ said Jimmy.  
‘Those are chickens,’ said Crake. ‘Chicken parts.  
Just the breasts, on this one. They’ve got ones that  
specialize in drumsticks too, twelve to a growth unit.’”

—*Oryx and Crake*, Margaret Atwood (2003)

### Introduction

In December 2020, California start-up Eat Just served its lab-grown chicken at 1880, a private members club in Singapore. In the same month, Israeli start-up SuperMeat launched The Chicken, a test restaurant in Tel Aviv to promote their own version of in vitro poultry. Such ventures are the result of a combination of a decades-long, international history of academic research, the rise of the startup movement, and for-profit R&D into in vitro meat (IVM).

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Positioned as a techno-utopic solution to animal suffering as well as to the myriad negative environmental effects of factory farming, IVM—also known as cultured meat, lab meat, cell-based meat, slaughter-free meat, and clean meat—is also the realization of over a century of speculative imaginaries; long before it was ever technologically possible to produce cultured meat, it existed in the cultural imagination through its appearance in science fiction. Sf narratives, in fact, have not only anticipated the emergence of cultured meat, but have also been used as framing devices for it, both in the media and in IVM companies' own marketing.

This article argues that the cultured meat boom can be better understood by framing it within sf studies, both historically and especially contemporarily. It begins with a concise history of the development of IVM in the real world before situating IVM within the history of sf. In doing so, it discusses the use of sf tropes in public and corporatized discourse around IVM, drawing on Veronica Hollinger's framing of sf as a mode—that is, “a way of thinking and speaking about contemporary reality so that SF becomes integrated with other discourses about late-capitalist global techno-culture” (140). Now that cultured meat, as of 2022, is rapidly approaching retail scalability, there is an even greater rationale for reading IVM in contemporary sf as a method of thinking through its material effects. The article therefore offers close readings of three sf works: Margaret Atwood's novel *Oryx and Crake* (2003), Elizabeth Dougherty's novel *The Blind Pig* (2010), and director Brandon Cronenberg's film *Antiviral* (2012). Each of these highlights—and critiques—a different facet of the sociopolitical and ethical tensions that arise from the adoption of IVM as a normalized foodway. *Oryx and Crake* puts pressure on the ethics of cultured meat production, in particular the animal welfare claims made in favor of IVM. It mobilizes the “cruelty-free” narrative of IVM to open up questions about genetic modification and the conversion of nonhuman animals (NHAs) into biotechnology. *The Blind Pig* examines the consequences of the “food as software” paradigm adopted by many IVM startups in the real world. It provokes questions about the fate of NHAs when all that is required to produce meat is their genetic information. *Antiviral* challenges the cannibalism taboo through the inclusion of human DNA in IVM, which, as Josh Milburn argues, can be one method of overcoming specieist hierarchies in the food system (Milburn). The film, even as it gestures towards the radical potential of no longer treating NHAs as completely disparate “Others,” also points to the dangers of the commodification of the building blocks of (human) life under a sort of “viral capitalism.”

Such sf visions of “new meat” highlight the instability in signification that is provoked by IVM, which requires both a distancing from and a connection

to the “animal” in order to “succeed” either as a retail product or in its self-assigned techno-utopic environmental and ethical mission. Despite its positioning as a break from the status quo, IVM is nevertheless still entangled in a longer history of meat and the human–NHA relationships around the food system, as well as in global networks of (greenwashed) capital. Even as it tries to extricate itself from conventional agricultural associations with place and space, IVM remains connected to place-specific material inputs and the global flows of consumer goods. Reading IVM in and through sf can help explicate the stories IVM companies want to tell about themselves, but, critically, it can also demonstrate the potential ethical, environmental, and world-ecological issues that remain obscured in those stories.

### **In Vitro Meat: Origins**

In order to understand IVM’s entanglements, it is first important to understand what exactly IVM *is*, including how it is produced, and who is doing the producing. Cultured meat was famously predicted in the early 1930s in Winston Churchill’s speculative essay “Fifty Years Hence” (1931) for *The Strand Magazine*, but has only just recently become an actuality. Churchill was not the first to predict the phenomenon; in 1894, Pierre-Eugène-Marcellin Berthelot, a French chemistry professor, claimed that people would be eating meat grown in a laboratory by the year 2000 (Shapiro, *Clean Meat* 9).<sup>1</sup> Nevertheless, the early history of culturing tissue resides almost entirely in the field of medical sciences. Perhaps the best-known early example is French biologist and surgeon Alexis Carrel’s “immortal” chick heart tissue cultures.<sup>2</sup> Carrel and his associate Albert Ebeling maintained the heart cultures at the Rockefeller Institute in New York from 1912 to 1946, greatly surpassing the lifespan of an in vivo chick (Jiang). Despite this success, it was not until the early 2000s that the first-known tissue culturing projects aimed at human consumption were attempted.

One such project, funded by NASA and headed by Morris Benjaminson, resulted in the growth of goldfish meat outside of a goldfish body, with the goal of developing the technology for use on space missions (Benjaminson, Gilchrist, and Lorenz).<sup>3</sup> The meat was not cleared for consumption by the FDA, so it was not tasted as part of the experiment, and NASA ceased funding soon afterwards as “long-term space flight was a low priority” (Stephens et al. 3). This study, however, helped catapult the launch of the IVM sector after it was read by Jason Matheny, who would go on to become the co-founder

of New Harvest, a nonprofit research institute focused on cellular agriculture (Schonwald). Around the same time as the NASA experiments, bioartists Oron Catts and Ionat Zurr were also producing meat outside of an animal body. The pair had been experimenting with cell culturing since 1996 as part of *The Tissue Culture & Art Project* (1996–2019), and claim that their *Semi-Living Steak* (2000) is “the first known proof-of-concept for using tissue culture exclusively for food” (Catts and Zurr, “Semi-Living Steak”). Their *Disembodied Cuisine* (2003) was the first example of meat grown from the cells of a live animal and then consumed. Based at L’Art Biotech exhibition in Nantes, France, the installation juxtaposed in vitro frog steaks with the live frogs from whom the biopsies to produce the meat were taken. On the last day, the frog steaks were cooked and consumed, although many of the diners spat them out (Edelman et al. 659; Catts and Zurr, “Disembodied Livestock” 106–107).

Building on these early attempts, the first cultured burger, created by Mark Post of Maastricht University (who would later become the co-founder of Mosa Meat) and funded by Google’s Sergey Brin, was publicly tasted in 2013. This was followed by the first cultured meatball in 2016 as well as the first cultured chicken sandwich and first cultured duck à l’orange in 2017, all executed by Memphis Meats (Shapiro, *Clean Meat* xi). The advances that began in academic laboratories and art studios had burst forth into the commercial realm. While not a single IVM company existed in the early 2000s, as of 2022, Aleph Farms (Israel), BioTech Foods (Spain), Mosa Meat (the Netherlands), VOW Foods (Australia), Future Fields (Canada), Higher Steaks (UK), Eat Just (USA), IntegriCulture (Japan), Clear Meat (India), and numerous others are all, at the time of this article’s composition, racing to produce viable alternatives to factory-farmed meat that are, unlike plant-based alternatives like Beyond Meat or Impossible Foods, still *meat*. In doing so, these companies extend and interrogate the signification of meat in the contemporary world, reframing it as a technological product which acts as a techno-fix in their respective utopian imaginaires.

Part of an emerging field of “cellular agriculture,”<sup>4</sup> IVM is grown directly from animal stem cells. The method predominantly used by these startups to produce cultured meat is the scaffolding method.<sup>5</sup> Stem cell lines are established from animal stem cells, immersed in a growth medium, and placed in a bioreactor to proliferate. A scaffold or carrier, such as collagen mesh, is used upon which the cells can grow. The cells are forced first to fuse into myotubes and then to differentiate into myofibers—that is, muscle cells—that can be eaten as meat (Edelman et al. 659; Bhat, Kumar, and Fayaz

245). This method, as of 2022, can only produce ground, boneless meat, although cultured meat that mimics real muscle is being developed in Japan, and scientists in Canada have recently developed a method of growing meat in sheets that can then be assembled into slabs (Marschall; Ho).

The original impetus for funding IVM research may have been for use in space travel, but the reasoning espoused by IVM startups and their supporters is now closer to home. “Just as we need clean energy to replace fossil fuels,” claims Paul Shapiro, “we need clean meat to replace factory farms. Switching to clean meat will be crucial for saving the planet from disastrous climate change and ecological degradation” (*Clean Meat* xii). Cultured meat is thus positioned as a panacea for the combination of a rising global demand for meat (especially in industrializing nations) and the problems with current (industrial) animal agriculture, whose negative effects include immense NHA suffering, antibiotic overuse leading to antibiotic resistance, water pollution from run-off, increased risk of zoonotic disease, biodiversity loss through conversion of land to pasture, and 14.5% of all anthropogenic greenhouse gas emissions,<sup>6</sup> as well as soil depletion through monocropping used for animal feed and other more tangential effects (Godfray et al.; Acari 31–36; Roberts xviii; Witte; Jones et al.; *World Livestock 2013*; Gerber et al.). Despite its description as environmentally friendly, however, the actual environmental benefit of IVM is in question; from an environmental impact standpoint, its advantages may not be outweighed by the intensive energy use required in its production (Mattick et al.; Smetana et al.; Aldes Wurgaft 7, 196).

The environmental reasoning for the production of IVM has, in line with the rapid expansion of ecologically focused sf and sf ecocriticism (see Canavan and Robinson), also made its way into recent sf which engages with cultured food. For example, the Singers, which are the source of “Neermeat” in *The Blind Pig*, are lauded for “giving the land and the oceans a chance to recover” (Dougherty 221). Despite its description as cruelty-free, IVM also provokes a number of questions related to bioethics and to the future of human/NHA relations. These range from worries about the potential dangers of genetic modification and bioengineering, to the control of bioinformation, to what will happen to NHAs if they are no longer considered “productive” in human society, to IVM “as an aspect of a still prevalent instrumentalist approach to other species” (Miller, “In Vitro Meat” 41) and its contribution to “meat culture.”<sup>7</sup> There has also been controversy regarding the inclusion of fetal bovine serum (FBS) in the production of IVM.<sup>8</sup> As Rasmus Simonsen explains, “The utopianism of bioengineered meat clashes with its own material actuality” (184). IVM’s enmeshment in larger capitalist networks

of productivity and profit is also an essential component of this bioethical problematic. Whether it will become yet another frontier for the accumulation of capital by multinational corporations, exacerbating the existing power imbalances between global North and global South, or whether it will become a method of decentralizing the food system, putting power back into the hands of communities is yet to be seen (Stephens et al.). As a place where the longer-reaching consequences of the wide-scale adoption of IVM can be worked through, sf is a productive venue for addressing the “culture” of cultured meat, including locating its various entanglements within societal structures, ethical debates, and a greater world-ecology.<sup>9</sup>

In the real world, the imagined possibilities for IVM are manifold, and often act as examples of the movement between the propositions of science and the realm of science fiction. Mark Post, for instance, has discussed the prospect of “mixing stem cells [...] to create truly hybrid muscle tissue—a Frankenstein-esque assemblage, no genetic modification necessary” (van Mensvoort, Andreotti, and Grievink 51). Alongside the obvious Frankenstein reference, his proposed lamb-tuna steak echoes the Kanga-Lamb of Atwood’s *Oryx and Crake*: “The Kanga-Lamb combines the high protein of the sheep with the kangaroo’s resistance to disease. The Kanga-Lamb is environmentally responsible and will no longer release methane while being reared” (Atwood 292). In the same vein, Post imagines a “prescription hamburger that lowers your cholesterol” (qtd. in van Mensvoort, Andreotti, and Guy 51), a concept reflected in the addition of supplemental nutrients to the Neermeat in *The Blind Pig*. He also proposes more unusual offerings such as “culturing tiger tissue for traditional Chinese medicine” (van Mensvoort, Andreotti, and Guy 51). These unusual creations also find expression in earlier sf texts, like the cultured lark’s tongues of Stephen L. Burns’s “Pleased to Meat You” (1988). Most compellingly, perhaps, Post—along with numerous others, such as Isha Datar, Paul Mozdziak, and Marie Gibbons—envisions a future in which meat is homebrewed similarly to beer, or cell lines are shared like sourdough starters: a “time when people like him will be ‘selling teabags of stem cells from tuna, tiger, cows, pigs, or whatever meat you want, and from the comfort of your own kitchen, you could grow your own meat.’” (qtd. in Shapiro, *Clean Meat* 23–24, see also 168; Ceurstemont). The Japanese nonprofit cultured meat collective Shojinmeat, which focuses on DIY, open-source cellular agriculture, is already working towards these at-home operations. Its co-founder, Yuki Hanyu, points directly to sf as an inspiration, explaining, “I started this whole thing because of science fiction. Cell-based meat happens everywhere in manga and anime sci-fi” (qtd. in Carter).

### “Grown in Suitable Media”: IVM in SF

In vitro meat is intertwined with sf in a number of compelling ways. To reiterate my earlier assertion, while IVM in real life may seem like a completely novel food, it in fact has a long history of being depicted in sf. As statements like Hanyu’s suggest, that history has helped to inspire its reality today. Notable examples of IVM in sf range from chemical meat in Mary Bradley Lane’s *Mizora* (1881), Chicken Little in Frederik Pohl and Cyril M. Kornbluth’s *The Space Merchants* (1952),<sup>10</sup> and butcher plants in Clifford D. Simak’s *Time is the Simplest Thing* (1961), to carniculture vats in H. Beam Piper’s *Space Viking* (1963), vat-grown meat in both William Gibson’s *Neuromancer* (1984) and Kim Stanley Robinson’s *Aurora* (2015), and cultured eggs and meat in Bina Shah’s *Before She Sleeps* (2018). The “ChickieNobs,” “Neermeat,” and celebrity steaks from the texts discussed in this article can also be added to this array of examples. Across these texts, which span a variety of sf subgenres, IVM is often framed as part of the technological adaptations of ecologically stressed or overpopulated futures. A handful of more recent texts play with the more creative possibilities of IVM. Koert van Mensvoort and Jan-Hendrik Grievink’s *The In Vitro Meat Cookbook* (2014) for example, includes meat paint and knitted meat. Ferrett Steinmetz’s *The Sol Majestic* (2019) features meat fibers spun like cotton candy. These locate aesthetics, pleasure, and whimsy in straying from the recognizable forms and exactitudes of in vivo animal cuts.

On the whole, IVM is presented—both in sf texts and in its real-life marketing—as a method by which humans can continue a particular mode of consumption that, in its in vivo form, has become increasingly environmentally and ethically nonviable. This reframing relies in particular on emphasizing IVM as “meat without the animal”: “the end product is presented as a food object that, as if by magic, can boast all the same nutrients as regular meat, but retains none of the negative connotations that mar the latter—the animal origin, or sign, has been effaced” (Simonsen 171). In doing so, IVM producers not only absolve themselves of any complicity in NHA suffering, but also, by virtue of highlighting the reduction of water, land, and other resource use, lean on a utopian post-scarcity imaginary (Simonsen 172) in crafting an ethos of desirability around their product.

If utopia is the good place that is no place, then this utopian meat is animal protein that is no animal.<sup>11</sup> This obscuring of origins, which can be read as part of a larger tradition of “food from nowhere” (Bové and Dufour 55; Maughan),<sup>12</sup> operates through and alongside a technological presentation of

meat as “food as software” (Sexton, “Food as Software”). Some of the most recognizable food in sf operates at the intersection of these two modalities. Perhaps the most well-known example of this is the replicator from *Star Trek: The Next Generation* (1987–1994). An advancement in technology from the protein sequencers (*Star Trek: Enterprise*, 2001–2005) and food synthesizers (*Star Trek: The Original Series*, 1966–1969) of *Star Trek*’s previous (by the show’s internal chronology) iterations, the replicator uses matter-energy conversion technology to effectively zap any food (or other inanimate object) into existence. In a preview of the technology in *Star Trek: Enterprise*, this includes fried catfish, despite the fact that Captain Jonathan Archer “doubt[s] there’s a catfish within 130 light years” (“Dead Stop” 00:13:50–00:14:00). Other notable examples include the Foodarackacycle in the TV show *The Jetsons* (1962–1963; 1985–1987), which dispenses complete dishes at the touch of a button, the matter-compilers which provide free food and water in Neal Stephenson’s novel *The Diamond Age* (1995), and the microwave in the children’s film *Spy Kids* (2001), which transforms what looks like energy bars into McDonald’s meals. A contemporary development of this trope is exemplified by the innovation of 3D printing and its associated marketing possibilities. Several recent sf works have turned to 3D food printing as a crucial element of their narratives, ranging from the brand-name printer in the Amazon TV series *Upload* (2020), which characters can use to print recipes tweeted by celebrity chefs, to the desktop food printer in John Feffer’s novel, *Splinterlands* (2016), which represents a significant improvement over seaweed simulacra in a world where “real” food is exorbitantly expensive, to the bioprinters in Vina Jie-Min Prasad’s short story, “A Series of Steaks” (2017), which allow her protagonist to forge premium steaks using “homegrown cloned cell lines.”

The connection between IVM and sf, however, extends beyond the fact that the emergent technology has a longer history of being depicted in sf works. While it is more tangentially connected to sf through its association with high-profile science research institutions such as NASA and the potential for its use in space travel, IVM’s place in the public sphere is explicitly entangled with sf narratives, reflecting Veronica Hollinger’s classification of “science fiction as one of the significant discourses of technoculture” (146). Critics and advocates alike reach for sf to explain and frame IVM, from news articles sensationalizing it as “science fiction becoming science fact” to op-eds that decry bioengineered foods as “Frankenfoods” (Shapiro, “Commentary”; Doughman; Hanlon; Kay).<sup>13</sup> In fact, IVM and other “New Food” companies *themselves* mobilize speculative narratives and sf tropes to contextualize their



products. Sf acts as the “discursive imaginary” (Hollinger 149) through which these companies construct their products narratologically. In claims that it will “disrupt” (a buzzword in startup culture) existing animal agriculture, IVM is simultaneously an actual technology that can produce “animal” flesh, and an exaggerated novum for the stories which New Food companies want to tell, stories that gain them access to the speculative finance of venture capital, even without a sellable product.<sup>14</sup> The public relations narratives pushed by New Food companies promise cleaner, brighter futures through a technoutopic novum which, they claim, will facilitate a post-animal food system.<sup>15</sup> There is a strong likelihood, however, that such utopian visions will remain speculative fictions, as evidence suggests IVM will most likely exist, for the foreseeable future, as a luxury alternative to, rather than instead of, industrial animal agriculture products.<sup>16</sup>

Some New Food startups’ PR narratives draw explicitly from the sf playbook; Rhys Williams, for example, points to a promotional video by Impossible Foods depicting an astronaut returning to a previously ruined Earth and finding life persisting (157–158). These narratives rely on audiences’ at least implicit awareness of an sf mega-text (Broderick). Others ask questions that could be, at first glance, sf writing prompts. A video depicting Eat Just employees eating cultured chicken nuggets made from Ian the chicken as Ian struts nearby, for instance, poses the question, “In the future, will we have our chickens and eat them too?” (New Food Economy). All rely on a timeline that stretches far into the future, their claims for environmental and NHA salvation as yet merely aspirational and likely overly optimistic (Stephens et al. 161), particularly considering the funding and support networks in which many IVM startups participate.<sup>17</sup>

Given IVM’s entanglement with sf through its historic representation in the genre and through the use of sf tropes in its portrayal in the real world, what place does that leave for IVM in contemporary sf? What can contemporary sf do for an understanding of IVM that has not already been done? The answer lies in the speculative extrapolation and sustained narrative focus that contemporary sf can put on the material consequences of the widespread adoption of cultured meat in their respective societies. The three contemporary sf narratives explored in this article begin to answer questions like the one posed by Eat Just about having our chickens and eating them, too. They do so in the shadow of the actual emergence of IVM technology. This is likely true even for *Oryx and Crake*—written in the early days of cultured meat attempts—which charts the movement between the genetic modification of livestock and IVM.<sup>18</sup> The three works also do so in the shadow of anthropogenic climate change

and unethical and unsustainable industrial animal agricultural practices, and the various technofixes that have been proposed to address them.

### **Nonhuman Animal Ethics and IVM in *Oryx and Crake* (2003)**

*Oryx and Crake*, the first novel in Atwood's post-apocalyptic MaddAddam trilogy (2003–2013), depicts a stratified techno-meritocratic near-future society in which bioengineering is a central and highly monetized concern. Those employed by powerful private companies, primarily in the biomedical field, live in guarded, self-contained compounds, outside of which are the lawless Pleeblands. The narrative in many ways epitomizes Joan Gordon's assertion that "Sf becomes the storyteller's way to make clear that science is also a narrative with its own biopolitical and cultural bias" (336). The compounds are sites of innovation, invoking hubs such as Silicon Valley, sites where employees and students attempt to innovate themselves out of (climate) crisis, but also sites where crises are created out of which one must innovate. In the novel, cultured meat is one such innovation, and is represented primarily through "ChickieNobs," bioengineered chickens created by the NeoAgriculturals section of the Watson-Crick Institute. Reminiscent of broiler chickens in the real world, which are bred to grow bigger and faster specifically for meat production, the "high growth rate's built in" (Atwood 203). Unlike broiler chickens, however, these have no real heads, no beaks, no eyes, and no brain functions aside from those "to do with digestion, assimilation, and growth" (Atwood 203): "What they were looking at was a large bulblike object that seemed to be covered with stippled whitish-yellow skin. Out of it came twenty thick fleshy tubes, and at the end of each tube another bulb was growing" (Atwood 202). These bulbs, as one of the epigraphs to this article reveals, are chicken breasts.

While the ChickieNobs are not necessarily an example of IVM as it is understood now—that is, meat grown directly from stem cells and not attached to a living creature—they are nevertheless an example of meat produced in a laboratory. They represent a step away from traditional (phenotype-based) breeding and genetic marker selection.<sup>19</sup> They are a provocation, an *ad absurdum* parody of the broiler chicken, but they are also more than merely a commentary on industrial agricultural practices; they prompt larger ethical questions about the bioengineering of NHAs. Reading *Oryx and Crake* in an age of widespread IVM development means that the ChickieNobs enact a twofold critique. Firstly, with their objectification comes a means

of understanding the way NHAs in the industrialized agriculture industry become mass-produced, de-animalized objects. This reading is supported by a running critique of consumer culture in the novel, which lambasts consumer excess, the marketing of scientific solutions to every known (and invented) issue or affliction, and the commodification of nature. As Marcy Galbreath, referencing environmental activists Wendell Berry and Michael Pollan, explains, factory-farmed livestock are seen as production units or machines rather than living creatures (Galbreath 3). The ChickieNobs are engineered for efficiency: “You get chicken breasts in two weeks—that’s a three-week improvement on the most efficient low-light, high-density chicken farming operations so far devised” (Atwood 203). They are merely biomachines for the production of protein and profit; the Watson-Crick students who invented ChickieNobs are “going to clean up [...] Investors are lining up around the block” (Atwood 203). The ChickieNobs thereby demonstrate, through an exaggerated novum, the “instrumentalist approach” (Miller, “In Vitro Meat” 41) to NHAs critiqued by John Miller.

Secondly, and perhaps most importantly, as not-quite-poultry, not-quite-IVM, the ChickieNobs act as a bridge that demonstrates the movement between NHAs as *animals* and NHAs as *biotechnology*. They are the next step in a lineage of NHA subjugation for profit, but this time at an explicitly genetic level—what Uma Valenti of Memphis Meats has referred to as the “second domestication” (qtd. in Shapiro, *Clean Meat* 10). Significantly, they place IVM on the continuum of the transformation of livestock into abject objects by presenting them not as meat grown from cells in petri dishes, as in real-life IVM, but rather as something close to—but not quite—recognizable poultry. The ChickieNobs thereby highlight one of the central contradictions of IVM, as noted previously. In order to succeed as a product, IVM needs to be identified as *meat*, as opposed to plant-based “meat” products or vegetarian/vegan alternatives like tofu. It simultaneously, however, needs to be distinct from *animal*, to maintain distance from the negative associations of industrial animal agriculture. The ChickieNobs reassert the animal-ness of lab-grown meat, even as the animal-ness they depict is contorted and horrific.

An animal welfare narrative is an integral part of both IVM discourse and the justification for the ChickieNobs. The Eat Just promotional video in which Ian the chicken is both alive and present and freshly fried into chicken nuggets, for example, features a voiceover that proclaims, “we figured out how life really works, and now we don’t need to cause death in order to create food” (JUST Egg). This is, of course, the same Eat Just that used FBS to produce their cultured chicken for their Singapore launch in 2020 (Carrington). In this

way, IVM aligns itself with an extant history of “happy cow”-style marketing narratives, ones that depict content animals grazing in large green pastures in contrast to the actual conditions of the NHAs in their supply chain. Satirized by Douglas Adams’s Ameglian Major Cow (who *wants* to be eaten) in *The Restaurant at the End of the Universe* (1980), and unambiguously portrayed in the California Milk Advisory Board’s “Great Milk Comes from Happy Cows” campaign and by brands such as La Vache Qui Rit (Laughing Cow), “happy cow”-style iconography helps to erase the monstrous reality of industrial agriculture. They explicitly encourage what Nancy McHugh describes as a politics of ignorance; that is, ignorance actively perpetuated in order to maintain a psychologically safe and cohesive status quo, one that does not harm one’s understanding of one’s self (as, for example, a person who would not inflict harm) (McHugh 41–43). *Oryx and Crake* demonstrates the potential extent of this politics of ignorance. Even after having visited the “nightmare” (Atwood 202) ChickieNobs, Jimmy, the main protagonist, later brings home a “ChickieNobs Bucket O’Nubbins,” remarking that “the stuff wasn’t that bad if you could forget everything you knew about the provenance” (Atwood 242).

In the novel, this willful ignorance is explicitly united with the humanitarian, pain-free narrative of IVM. The ChickieNobs are not happy chickens, but rather “hookworm” (Atwood 202) chickens; described as “like an animal-protein tuber” (Atwood 202), they are engineered to feel no pain. Their inability to feel pain is celebrated, not out of concern for the creatures themselves, but because “the animal-welfare freaks won’t be able to say a word” (Atwood 203). The main ethical objection to their sale is circumvented, allowing for their continued use for/as profit. The pain-free label obscures the questionable ethics of how exactly the ChickieNobs were developed to feel no pain in the first place, and in this sense is comparable to the way that the pain-free marketing for IVM obscures the initial use of FBS, the funding from Big Agro, and other ostensibly problematic practices behind its production.

*Oryx and Crake*, through its specific portrayal of lab-grown meat, begins to track a transformation in the genetic manipulation of NHAs for the benefit of humans. While the ChickieNobs are not transgenic<sup>20</sup> like other figures in the text such as the “pigoons” (pigs genetically modified to grow human organs for biomedical purposes), they nevertheless gesture toward fears associated with “Frankenfood,” particularly the perceived monstrosity of genetic modification (GM). Although the grotesque exaggeration of the ChickieNobs arguably capitalizes excessively on anti-GM sentiment, the creatures nevertheless provoke valuable questions about the ethics of manipulating NHAs’ biology for the benefit of humans, criticizing an approach to NHAs that sees them

only as production units or as biotechnology. They also gesture towards larger questions about the nature of the *animal* in a technologized and digitized world. How much can NHAs be altered before they are no longer (the same) animals anymore? What does GM change about human-NHA relations? And what might happen to living NHAs if they are only needed as genetic materials for geneticists to experiment with? These questions, implied by *Oryx and Crake*, are taken up more explicitly in *The Blind Pig*.

### **“Food as Software” in *The Blind Pig* (2010)**

Elizabeth Dougherty’s *The Blind Pig* is set in 2063, in a world in which climate change has significantly worsened and the industrial animal agriculture system has collapsed. In the novel, all “traditional” agriculture is illegal; food is provided instead by the government-controlled, privately supplied Nutritional Architecture System (NArc). NArc food—known as Neerfood—is made from genetically modified crops and formulated based on individual nutritional and health needs, which are assessed “by injected nano bots and implanted chips” (Dougherty 63). The NArc replaces both the food and healthcare systems, though there is an underground foodie network. The novel’s analogue for IVM is Synganium, or Singers: “a twist of organs and veins that formed a heaping spiral inter-connected by tubes and signaling wires. [...] At the edges grew bands of harvestable flesh. Neermeat” (Dougherty 114). Neermeat can be infused with Omega-3s and other nutrients to form an integral part of a NArc meal.

The NArc is a system that envisions food as software, i.e., “food as a composition of elements as opposed to something that takes its identity from its origin” (Williams 153).<sup>21</sup> The construction of NArc meals is similar to the way nutritionists may break food consumption down into macros (proteins, carbs, and fat), or that diets may have adherents count their calories. Instead of starting from existing foods, however, the NArc builds the foods from the ground up. In doing so, it enacts an untethering of food from its rootedness in place and space. In the case of cultured animal products in particular, it untethers food from its embodiment in/as the animal, which, as Alexandra Sexton explains, “has created an unprecedented juncture in the ontological politics of food. Cowless milk and slaughter-free meat have not only created new questions and possibilities of what these foodstuffs *are* but also what they can and should be” (Sexton, “Food as Software” 450).<sup>22</sup> An understanding of food as software, and thereby a focus on “thinking

of food as information that can be built up from its component parts” (Williams 153) also works to distance food from its place in a world-ecology. “To move the basic unit of production from macroorganisms to microorganisms like this,” explains Rhys Williams, “is to uncouple food production further from the ecosystemic modes and relations that we call nature, and to reground it in those infrastructural modes and relations of production we call capital” (Williams 153). Like the replicator, which can produce a catfish out of nowhere, the NArc does not need to rely on larger food networks and global supply chains. In contrast to the local and regional food networks championed by food sovereignty activists in the real world as a way to place power back into the hands of farmers, however, the NArc operates as an iron-fisted monopoly, partly due to the technological nature of its products. This gives those who control the NArc immense power, alongside a desperate need to maintain that power at any cost.

It is a critique of the authoritarian governmental control that forms the thrust of the novel. While GM food *is* pitted against illicit “real” food (which is cast as unsafe, unclean, and unhealthy) during Angela, the protagonist’s foray into the foodie underground as an investigative journalist, it is ultimately the manipulation of facts, data, and the scientific method undertaken to maintain total societal reliance on the NArc that becomes the object of the novel’s criticism. Nevertheless, in the course of her investigation, Angela uncovers a number of ethical and ecocritical questions associated with NArc food, and in particular, Neermeat. These include moral dilemmas about the fate of meat animals, particularly as they figure in the “food as software” paradigm.

*The Blind Pig* is not quite a Sixth Extinction novel.<sup>23</sup> Animals still exist, though within the borders of NArc control they are confined to museums, including one that operates as a front for an illegal working farm. During a tour of the farm, Herb, the farmer, brings up a common argument in favor of meat-eating, but quickly pivots to the implications of a digital turn:

“If we didn’t eat ’em, these animals probably wouldn’t even exist anymore.” Herb paused. “Least, that’s what I used to think.” He sighed and wiped his brow. “My son says all these animals exist in theory. They exist in DNA form. Digitally. He says that if we want to, we can just make ’em again. They use pig genes to make the meat in those Singer-thingies and whatnot. Mattie says that the engineered stuff they call Neermeat is the same as the muscles on these piglets, so I guess they exist that way too.” (Dougherty 203)

This passage, and Herb’s subsequent conclusion that slaughtering a pig and having “to face him” (Dougherty 203) feels more humane than creating pig

parts in a laboratory, gestures toward several complex ethical considerations that are similar to the ones provoked by *Oryx and Crake*. By reducing animals to just their useful parts, grown in a lab, are they being more devalued? Is it better to give animals a life (that might be filled with suffering, or might not), and to face them as they are killed, before breaking them down into their constituent parts and consuming them? And what if we don't consume them at all? Is there any ethical obligation to maintain domesticated animal populations? Through its future imaginary in which NHAs are differently (and additionally) marginalized, the novel compels the reader to reconsider these questions at a moment in which innovative food technologies are already working to transform an understanding of the "animal" in the real world.

Paul Shapiro claims that animal welfare concerns may gain greater traction if humans no longer use in vivo animal agriculture: "once kerosene helped replace whale oil in the nineteenth century as our primary lighting fuel, it became a lot easier to start caring about the welfare of whales" (*Clean Meat* 231). By eliminating the need for a politics of ignorance, the adoption of cellular agriculture may make it easier to care about the ethical treatment of animals. Would animals then cease to be, per Sherryl Vint, "always-already meat" (28)? John Miller disagrees. He explains that "in vitro meat appears not as a radical solution to the violent subjection of nonhuman animals within industrial capitalist cultures, but rather as a further symptom of the remarkable extent of this violence" (Miller, "In Vitro Meat" 45). If some humans are willing to participate in engineering away the animal-ness of the animal in order to make it more profitable and useful, rather than adopting any number of vegetarian protein substitutes, how likely is it that more care will be paid to live NHAs who are now no longer of use? In Miller's view, the answer to whether NHAs are more devalued by existing only as useful parts grown in a lab is a resounding yes. Josh Milburn elaborates on this point, explaining that a devaluation takes place even if animals are not harmed:

The idea is that in choosing to eat NHA flesh even if we do so in a way that is consistent with their interests in not being made to suffer and not being killed, we affirm a kind of *pathos of distance* between "us" and "them"; a kind of ranked hierarchy with humans above and NHAs below. (Milburn 256)

In this view, IVM retains a human exceptionalism and can therefore participate in the further distancing, and ultimately erasure, of the animal, obscuring the interconnectedness of human and nonhuman animals as part of a larger ecosphere. The project of "food as software" relies on this thinking of "nature" as a sum of its parts rather than an interconnected whole. In *The*

*Blind Pig*, this viewpoint is explicitly articulated. One character explains that, while animals may still exist as DNA sequences, “what we didn’t bottle is all the intricate connections, the ecology, the balance. We have a catalog of all the parts, but we don’t know how they fit together” (Dougherty 203).

Both the possible futures described by Shapiro and Miller exist, suspended, in the promise of IVM. It is possible that both might come to exist in different cultural contexts. Considering the trajectory of continued global expansion and exploitation of the periphery by multinational companies based in core countries—which promotes an attitude of exploitation towards both certain humans and NHAs—however, it seems unlikely that Shapiro’s vision will be the more common one. Does this mean that lab meat is inherently bad? Not necessarily. *The Blind Pig*’s protagonist explains, “the old studies showing that we cannot feed the world with traditional agriculture still hold true. And since then, we have only expanded the population and exacerbated the problem” (Dougherty 301). In the novel, Singers are an imperfect but viable solution to an urgent problem, reflecting the narratives offered by IVM proponents in the real world that lab-grown meat is a viable solution to an increasing global demand for protein. They also, however, underscore the potential problems of “food as software” and the entanglement of IVM in startup culture in real life. One character in the novel describes the NARC as “engineering pretending to be science” (Dougherty 256). She continues, “They made things work on the surface, put some weak statistics together to get them approved for sale, then scrambled to fix the bugs. That might have been fine for games and gadgets [...] but it’s not okay when we’re talking about the food we eat” (Dougherty 256). With pressure from their financial backers to produce a viable product, paired with the “move fast and break things,” “growth at any cost” culture of Silicon Valley (Cook 79–81), real-life IVM companies are at risk of committing the same types of mistakes—like Eat Just’s use of FBS despite their cruelty-free ethos in order to “be the first” with their Singapore launch. While animals may not be “always-already meat” (Vint 28) in these conceptions, they (or at least their cells) are certainly considered always-already profit.

The inclusion of objectionable ingredients such as FBS in IVM also appears in *The Blind Pig*, although with a different type of ingredient: human DNA. Patrick D. Hopkins and Austin Dacey note that the fear of transgressing the cannibalism taboo is one of the major objections to IVM, but it is not a current and present danger (586).<sup>24</sup> In *The Blind Pig*, however, it is already a reality.<sup>25</sup> When one of the characters balks at the idea of adding a human regulatory system to the Singers, his scientist love interest, Molly, retorts:



You do know that they already have human parts, don't you? Not the Neermeat we harvest from them, of course. But some of the organs are derived from human cells. They just work better in the system. Besides, at the level we synthesize them, it's pretty difficult to think of any of the parts as human or anything else. They're just components. DNA. Proteins. (Dougherty 181)

Molly's rebuttal is at odds with Herb's claim above that pigs continue to exist through the use of their DNA in the Singers and reinforces the conception of NHAs as a collection of useful parts. Yet, simultaneously, the use of human parts also subverts species hierarchies by considering humans *also* as a collection of useful parts to be mined for scientific purposes. Josh Milburn advocates for such an approach in the contemporary debate, arguing that "we should be open not just to the production of in vitro nonhuman flesh, but also in vitro human flesh" (Milburn 249). He explains that not banning any type of IVM flesh production prevents the hierarchizing of humans and NHAs (as well as certain NHAs above other NHAs): "Nothing is off-limits: Human, dog, panda, chicken, (mammoth?)—to say otherwise breaks animal life into two, and creates (or continues to affirm) a pathos of distance" (Milburn 257). If one accepts the premise of IVM as a pain-free and ethically sound meat alternative, one must also accept that it subverts sentimental arguments that allow for the consumption of, for example, ducks but not puppies, cows but not people. In this view, IVM production circumvents many of the dangers and moral objections associated with cannibalism, leaving only an instinctive (cultural) reaction of disgust as the predominant objection (Milburn 259–262).

In the real world, IVM made from human cells has been the subject of a controversial, high-profile art exhibit. "Ouroboros Steak," designed by Andrew Pelling, Orkan Telhan, and Grace Knight, proposes auto-cannibalism as "an absurd solution to a serious problem" (Pelling, qtd. in Small), aiming to shock audiences into "an examination of environmental responsibility and the clean-meat industry" (Small). Significantly, there has been industry interest in the project, which is essentially a DIY kit to grow meat from your own cells; according to an article in *The New York Times*, "Dr. Pelling said that he has also received inquiries from several venture capitalists looking to invest early in 'Ouroboros Steak' or join an accelerator program" (Small). Pelling, Telhan, and Knight are not the only bioartists working on this; Kankaro Osada, a member of the Shojimeat collective, plans to grow meat using her own cells as part of her PhD thesis (Carter). The *In Vitro Meat Cookbook* and its partner website *Bistro InVitro* also include an entry for "In Vitro Me!," a personal bioreactor that grows "a small effigy grown from your own stem cells" (Submarine Channel and Next Nature Network; Rutzerveld 147),

as well as one for “Celebrity Cubes.” BiteLabs, a venture founded in 2014 and situated somewhere between biotech startup, social media campaign, and avant-garde art project, aims to make artisanal salami from celebrity stem cells, encouraging fans to tweet their favorite celebs to encourage their participation (“BiteLabs”).<sup>26</sup> While the auto-cannibalism projects are scenarios in which “you are at least giving consent by taking your own cells” (Small), the “Celebrity Cubes” and celebrity salami form more of a grey area in which exploitation is more possible. *Antiviral*, which features celebrity steaks, explores this grey area in greater depth.

### **Cultured Cannibalism and Viral Capitalism in *Antiviral* (2012)**

While *The Blind Pig* avoids the consumption of human flesh by incorporating human parts only into the inedible segments of the Singers (and *Oryx and Crake* only hints at potential cannibalism through its pigeons), the French-Canadian sf/horror film *Antiviral* explicitly depicts the consumption of IVM human meat. *Antiviral* is set in a society of extreme celebrity worship. Syd, the protagonist, works at the Lucas Clinic selling celebrity illnesses to fans, as well as smuggling out those same illnesses in his body and reverse engineering them for the black market. Syd’s fence is Arvid, a butcher who specializes in IVM celebrity steaks, and a good portion of the action takes place in his butcher shop, Astral Bodies. In one exchange with Arvid, Syd explicitly questions the ethics of culturing meat from celebrity stem cells:

Syd: “I don’t understand how this isn’t considered cannibalism.”

Arvid: “Well, these are just muscle cells. It all depends on whether the human being is found in its materials. Right now, the law tends towards something more religious. We’ll see what happens when we go from growing celebrity cell steaks to growing complete celebrity bodies” (*Antiviral* 00:21:22–00:21:44).

Molly’s scientific argument in *The Blind Pig* regarding the lack of species specificity at the cellular level is matched here by a religious refiguring of the same idea. For her, stem cells are components and DNA, not people. In the *Antiviral* conception, it is not the flesh that makes a human “human,” but rather the soul. Just as there isn’t a “cow-ness” to a lab steak, there isn’t a “human-ness” either; it is not, therefore, technically cannibalism.<sup>27</sup> This viewpoint is compounded by the owner of the Lucas Clinic, Mr. Lucas, quipping that “celebrities are not people. They’re group hallucinations” (*Antiviral* 00:12:30–00:12:35). Following Simonsen, meat made from cells is

decoupled from its association with its corpulent origins. It is abstracted, becoming a cultural object, and its depiction in the film as wrinkled, anemic white slabs enacts a matching physical abstraction from an association with traditionally red and vibrant steaks. The “culture” aspect of cultured meat is thereby highlighted in *Antiviral*’s depiction, demonstrating how IVM might be mobilized to complement a societal ideology of consumption, here taken to its extreme.

In the same scene, Syd is also shown Arvid’s cell garden, in which he is experimenting with growing “plants” from stem cells. Reminiscent of the work of bioartists Catts and Zurr, these “plants” are supported by tree-like glass posts. Potentially symbolic of human reconfiguring of the environment, they are positioned as the inspiration for the Hannah Geist AfterLife Capsule. After being infected with a patented virus created by Vole & Tesser—originally used to infect celebrity Hannah Geist in order to allow them to circumvent her exclusivity agreement with the Lucas Clinic on the sale of her illnesses—Syd proposes the AfterLife Capsule as a bargaining chip (“The technology already exists... and I know where to find it” (*Antiviral* 01:38:20–01:38:27)) to compel Vole & Tesser to design a cure for him. Through this capsule, which recalls the iron lungs of the 1920s and 1930s, “the system that is Hannah Geist’s body has been perpetuated, even expanded beyond what existed during her lifetime” (*Antiviral* 01:39:35–01:39:44). This expansion is what is ultimately contested in IVM.<sup>28</sup> As Melinda Cooper explains, “In short, what is at stake and what is new in contemporary biosciences is not so much the commodification of biological life—this is a foregone conclusion—but rather its transmutation into speculative surplus value” (Cooper 148). Capsule Hannah’s value is entirely based on speculative surplus value. Moreover, “When bodies are constituted as information,” as N. Katherine Hayles explains, “they can not only be sold but fundamentally reconstituted in response to market pressures” (42). Hannah’s body is no longer her body, but rather “the system that is [her] body” that can be corporatized and manipulated to fit the needs of the market. Vole & Tesser injects viruses into the system, allows them to incubate, and then extracts them to sell to consumers, relying on marketing and market predictions of continued fan interest. *Antiviral* also visually literalizes the “surplus” in Hannah’s surplus value, with shots of her face inside the capsule showing extra fleshy tendrils growing from one side of her head.

Hannah’s value also involves her removal from the normal chronology of the human body. As NHAs in *The Blind Pig* are preserved forever in their DNA strands, ready for manipulation to serve NArc purposes, so too is Hannah’s body preserved in the AfterLife Capsule. Paralleling the immortality

that comes with the continued consumption of her media work, she is made physically immortal in much the same way as Alexis Carrel's "immortal" chicken cells. This follows the visual fracturing of her body on screens in various scenes in the film, simultaneously invoking a notion of celebrity as a blank slate on which people's aspirations and desires are projected and the violent fragmentation and subjugation undergone by both women and animals that is described by Carol J. Adams in *The Sexual Politics of Meat*.<sup>29</sup> The film therefore falls on the extending violence side, argued for by Miller and Milburn, of the IVM debate. It also, however, expands questions of the animal taken up in the IVM argument to encompass the problematics of the contemporary evolution of capitalism into biocapitalism.

Hannah effectively becomes a Chicken Little (in the Pohl and Kornbluthian sense) for what Sean McQueen, drawing on Thierry Bardini's theory of genetic capitalism, describes as viral capitalism. McQueen explains:

The viral, then, relates to contemporary economies of finance and speculative capital, where the play of value becomes more profitable than industrial production, information replaces traditional commodities and genetic material becomes versatile and profitable once it is rendered as information (abstracted from the body) and its ownership becomes contested. (McQueen 33)

The ownership of genetic information (i.e., the viruses), is certainly contested in *Antiviral*, philosophically if not legally. Capsule Hannah is only a fleshy bioreactor for viruses, a resource from which corporations can continually skim profits; in fact, the Vole & Tesser plot relies on the fact that a patented virus that passes through her body would still remain the property of the virus creator. Yet, somehow, this capsule conduit Hannah is framed as more-Hannah than IVM steaks made from her cells: "Make no mistake, however: this is not some glorified cell steak. Everything inside this housing is either part of the original body or has been grown directly from it, as a result of our patented cell-garden technology" (*Antiviral* 01:39:45–01:40:01). The profitability of the illnesses filtered through the AfterLife Capsule relies on their intimate connection with Hannah, yet they can only exist because they are considered distinct from her, and she is afforded no agency or ownership over them. The questionable appeal to legitimacy in Vole & Tesser's pitch highlights the different registers of signification that must coexist in IVM, which is simultaneously materially "animal" and disembodied. The cell steaks, likewise, are somehow literally Hannah (from her cells) and not-Hannah-enough (not from her original body). Both products rely on linguistic and cultural framing, highlighting the polysemous nature of IVM. Whether they are NHA/human

or not-NHA/not-human depends, as Arvid implies, on societal mores shaped by cultural beliefs and institutions. How IVM is “read” based on these norms can have material consequences for the NHAs (or people) whose cells are implicated. The potential for in vitro *human* meat to help bring forth a eutopic future in which all NHA rights are respected and valued equitably, then, must exist in resistance to the commodification of all life under viral- or biocapitalism, in which (most) humans are increasingly both the workers and the products, with the means of production still out of reach.<sup>30</sup>

## Conclusion

Depictions of lab-grown meat in science fiction stretching as far back as 1881 have set the stage for the sociocultural framing of IVM technology in both public and corporate discourse. This discourse includes that of the political sphere, in which IVM forms an important part of the techno-utopic imaginaries articulated by figures such as Churchill and Birkenhead. Cultured meat, which traces its technological roots to advances in biomedicine, first became the subject of bioartistic experimentation and academic research before being taken up as the product of choice for a growing phalanx of cellular agriculture startups. These startups, their proponents, and even their detractors reach for sf and utopian tropes to help frame their products, drawing on sf not only as a literary genre but as a mode of discourse. Now that, as of the time of writing, IVM has already been tasted by some members of the public and is poised to become scalable for retail distribution, an attention to its potential *material* consequences for nonhuman animals and humans alike is essential. As a technological “New Food,” IVM provokes questions about what “meat” and meat culture is and might become, particularly in the shadow of climate emergency and the larger range of technological solutions being developed to ostensibly change the ways humans interact with the world.

This article has argued that contemporary sf featuring cultured meat is well-poised to provide a venue for the exploration of these types of questions. Atwood’s *Oryx and Crake*, Dougherty’s *The Blind Pig*, and Cronenberg’s *Antiviral* each emphasizes different ethical problematics associated with the growing of meat in a laboratory, namely NHA welfare concerns in a production context; the problems of “food as software” and the fate of NHAs when they are *removed* from the production context; and the (radical) potential of in vitro “cannibalism” and the fate of genetic material as information under viral/genetic capitalism. Each highlights the destabilizing potential of IVM for

understandings of the “animal” as it becomes entangled in issues of biotechnology, consumer culture, and structures of capital production. Each ultimately implicates the co-opting of cellular agriculture into monopolizing, capital-driven food-systems in the questionable ethical frameworks that develop around IVM in their fictional worlds. In doing so, they help to illuminate the obstacles in the real world that block the path of the “cruelty-free” future promised by cultured meat companies, especially as those companies form part of a web of venture capital backing and startup culture, which seeks to differentiate itself from—but ultimately is still enmeshed with—industrial animal agriculture.

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### Notes

- 1 Churchill was also likely echoing his contemporary, British statesman Frederick Edwin Birkenhead, who wrote in *The World in 2030 AD* (1930) that, by 2030, proteins would either be produced synthetically or that “the more highly prized varieties of animal foods—such, for example, as beefsteak or chicken’s breast—will be grown in suitable media in the laboratory. It will no longer be necessary to go to the extravagant length of rearing a bullock in order to eat its steak. From one ‘parent’ steak of choice tenderness it will be possible to grow as large and as juicy a steak as can be desired” (Birkenhead, *The World* 19; a version of this was first published in *Cosmopolitan* in 1929, see Birkenhead, “Save This” 178).
- 2 The supposed immortality of Carrel’s tissue cultures is in dispute; they may have been renewed with the addition of fresh tissue (Witkowski).
- 3 The meat was grown from an “explant,” that is, a section of meat cut from an existing goldfish, rather than from a stem cell line. The same team attempted to grow chicken meat, but this venture was less successful (Stephens et al. 3).
- 4 Other cellular agriculture ventures include milk (Perfect Day, USA) and egg whites (EVERY, USA) made from yeast, cultured fish (Finless Foods, USA; Blue Nalu, USA; Avant, Hong Kong), biofabricated leather (Modern Meadow, USA), cultured foie gras (Gourmey, France), cultured shellfish (Shiok Meats, Singapore), and cultured animal fat (Cubiq Foods, Spain; Peace of Meat, Belgium).
- 5 The other main method is self-organizing, in which pellets of animal tissue are left to grow in petri dishes of growth medium. These cells are more able to mimic in vivo structures, but they necrotize if separated from the nutrient supply because of the lack of blood circulation (Bhat, Kumar, and Fayaz 245).

- 6 This number is according to an FAO report from 2013. Estimates vary, with one as high as 51% (Goodland and Anhang), although they do not seem to dip below 14%. For an overview, see Acari 31–32. David Cleveland explains that differing boundaries of what should be considered part of the agrifood system (direct agricultural production vs. including vegetation loss from converting land to pasture, energy for delivering water and other inputs, etc.) can account for vast differences in these calculations (Cleveland 213–214).
- 7 “Meat culture” refers to the association between meat-eating and a worldview that can be mobilized to subjugate women, people of color, LGBTQIA+ people, and other marginalized populations such as immigrants, as well as NHAs (A. Potts; Wolfe 8). Meat has been used as an indicator of wealth, progress, and success as they are figured in global capitalist logic (Chan and Zlatevska; Stock and Carolan 125). This logic generally also associates those qualities with being white, from the global North, and male. “What meat exemplifies, more than anything,” explains Nick Fiddes, “is an attitude: the masculine world view that ubiquitously perceives, values, and legitimates hierarchical domination of nature, of women, and of other men and, as its corollary, devalues less domineering modes of interaction between humans and with the rest of nature” (210). There has been extensive research on the various facets of meat culture, including on its relationship to gender (Adams), race (Brown; Parry; Rifkin), and disability (Linett; Taylor), as well as its relationship to national identity (Barthes; Fudge; Christou 5) and the flow of goods in an uneven and unequal world system (i.e., “protein imperialism”) (Caldwell 22).
- 8 FBS is harvested by cardiac puncture from fetuses taken from cows that are pregnant at the time of slaughter (Jochems et al. 219). It is used as a growth medium. At the time of writing, vegetarian substitutes are in the process of being researched and implemented, and IVM startups have distanced themselves from the ingredient. Despite this, as Neil Stephens has noted, FBS was used in the Singapore launch in December 2020 (Stephens; Carrington).
- 9 While I discuss meat here specifically, the “symbiotic relationship” (Gordon 339) between sf and animal studies more generally is already well established. See, for example, Gordon; Vint.
- 10 For more on IVM in *The Space Merchants*, see Miller, “The Literary Invention of In Vitro Meat.”
- 11 The ancient Greek word for utopia is *οὐτόπος*, made up of *οὐ* [not] and *τόπος* [place]. It was coined by Thomas More in 1516. When pronounced in English, it is a homophone for the ancient Greek work for “good place” (*εὐτοπία*). For more on the terminology, see Vieira.
- 12 Originally used by José Bové to refer to the depersonalized standardization (and globalization) of McDonald’s meals, the phrase “food from nowhere” is mobilized by Chris Maughan to indicate the obfuscation of the material realities (labor-power, resource ownership, transportation cost, etc.) of an energy-food nexus.
- 13 The first use of the term “Frankenfood” is likely from a letter to the editor in *The New York Times* in 1992, written by Paul Lewis. It since gained widespread traction in a variety of media, particularly in the late 1990s but continuing to the present (Lewis; Cerier). It is used to invoke horror and disgust, analogizing genetically modified

foods' composite nature to the construction of Victor Frankenstein's monster. It implicitly criticizes man's hubris in creating life via technological ("artificial") means. For more references to Frankenfoods, see, for example, Belasco xiii; Wallace 96; Kendal 99; François 45. For more on the terminology itself, see Welchman.

- 14 Startup investment is a high risk/high reward field. Venture capitalists (VCs) invest in the ideas of entrepreneurs, who must be able to create a compelling enough narrative that demonstrates their "high growth potential." VCs generally look to fund the commercialization stage of startups, when they are attempting to scale and bring their products to market (Zider), meaning that they have a concept and likely a prototype, but still need to develop the final, commercially viable product. Startups necessarily rely on speculative futures, as they promise innovation and progress to their prospective funders without yet having the funds necessary to do so. VCs invest for a variety of reasons, although tellingly, as Hegeman and Sørheim have shown in a study of Norwegian cleantech startups, "large companies invest corporate venture capital to promote corporate greening to maintain competitiveness" (1). The mobilization of speculative futures is not limited to startups, however, and a number of theorists argue that finance more generally relies on speculative futures. See, for example, Beckert; Davies.
- 15 I use the term "post-animal" here as a NHA configuration of the idea of the posthuman. It is also, however, explicitly part of the ethos of IVM start-up culture. As Benjamin Aldes Wurgaft explains, "within the cultured meat movement, 'the post-animal bioeconomy' became a buzz-phrase of sorts, used to describe a range of techniques, often involving tissue culture, for developing products humans have traditionally obtained from nonhuman animals" (Aldes Wurgaft 18).
- 16 The megacorporations that IVM startups propose to "disrupt" have already begun investing heavily in those same startups, incorporating them into their portfolios in the same manner that giants such as AB InBev offer craft beers from Goose Island or Kona Brewing alongside their Budweiser and Natural Light. For example, Tyson Foods, a massive multinational corporation with \$42.4 billion in revenue and the US's largest beef exporter, has invested in both Memphis Meats and Future Meat, as well as in Beyond Meat (plant-based meat), New Wave (plant-based shrimp), and more ("Tyson Ventures").
- 17 Alexandra Sexton argues, for example, that Silicon Valley's importance as a hub for IVM and other alternative protein startups has necessitated that these companies develop a culture and lexicon that allows them access to the social and financial capital of the region; "it has required a choice by ventures to become culturally in place and reimagine food through Silicon Valley's image of for-profit, high-tech innovation" (Sexton, "Food as Software" 464). This perspective is not one that easily leads to equal access to resources and systemic change to the food system.
- 18 Margaret Atwood's reliance on news clippings and existing scientific achievements as background for her work is well documented, as is her now-infamous insistence that her work is not science fiction but rather speculative fiction, as "speculative fiction could actually happen" (qtd. in R. Potts). She has since walked this back as a difference in defining terms (Ashbrook). The acknowledgments to *Oryx and Crake* even include a website which is said to contain a scrupulous list of sources, detailing



- the “deep background” that was “inadvertently supplied by many magazines and newspapers and non-fiction science writers encountered over the years.” The website is, unfortunately, defunct at the time of this writing (Atwood 376; R. Potts).
- 19 Genetic marker selection is the use of genetic markers, discovered via molecular genetic analysis, to select for certain traits when breeding livestock populations. It is considered an improvement over phenotype selection, which can be less accurate and often requires a longer and more costly process. For more, see Dekkers and Hospital; Twine 15.
  - 20 Transgenic animals are ones that have been genetically altered using genes from another species or breed.
  - 21 As Alexandra Sexton explains, this turn to “food as software” is partially due to the way startups acquire funding. Food is not seen as exciting or scalable for Silicon Valley VCs, who prefer to invest in algorithms and apps. In order to fit into these VC’s portfolios, New Food startups must market themselves as *technology* companies first, and *food* companies second (Sexton, “Feeding the World Silicon Valley-Style”).
  - 22 It is worth noting the implicit connections here to N. Katherine Hayles’s work on embodiment, informatics, and posthumanism. While Hayles herself does not delve into animal studies, Vint argues that Hayles’s work necessarily extrapolates to NHAs, and in particular to the human-animal boundary (Vint 78). This boundary is implicated in an understanding of what is or can become meat. Seen through the prism of food as software, I would argue that IVM is especially attuned to the issues around (dis)embodiment that Hayles raises.
  - 23 The Sixth Extinction is a current and ongoing (as of 2022) profound loss of biodiversity globally, largely considered to be caused by human activity (Ceballos, Erlich, and Dirzo; Kolbert).
  - 24 The other objections are: danger; naturalness; reality of meat; yuck factor; technological fix is moral cowardice; wrong moral motivations; the lives of food animals are better than nothing; taint of the source; animal integrity; a lack of moral regard, dignity, and respect; domination vs. reverence (Hopkins and Dacey).
  - 25 The use of a cannibalism novum is not an unusual one, although its integration into IVM is more novel. As Paul Alkon has explained, cannibalism in sf is a prime “device for cognitive estrangement. Because cannibalism is not likely to be a common feature of the real world in which readers live, accounts of cannibalism, whether grim or amusing, may easily, but do not invariably, invite us to look at familiar things from an alien perspective” (146). I discuss cannibalism in contemporary sf outside of the context of IVM elsewhere; see Castle.
  - 26 For an in-depth analysis of the sociocultural and ethical significance of BiteLabs, see Nye.
  - 27 This would, of course, make IVM not really meat, at least not in the traditional sense. Many vegetarians and vegans would disagree.
  - 28 While the context here is biomedical, the line between biomed and food science is a porous one, perhaps better understood under the umbrella term “bioscience.”
  - 29 While the main celebrity is female, both male and female celebrities are depicted, and male and female patrons are shown as equally interested in celebrities of different genders.

30 I rely here on the definition of eutopia as a positive utopia (i.e., a substantially better world than that of the reader) and dystopia as a negative utopia (i.e., a substantially worse world than that of the reader) championed by Lyman Tower Sargent and Lucy Sargisson respectively (Sargent 3, 9; Sargisson 8–10).

## Works Cited

- Acari, Paula. *Making Sense of “Food” Animals: A Critical Exploration of the Persistence of “Meat.”* Palgrave Macmillan, 2020.
- Adams, Carol J. *The Sexual Politics of Meat: A Feminist-Vegetarian Critical Theory.* 20th Anniversary Edition, Bloomsbury Academic, 2010.
- Aldes Wurgaft, Benjamin. *Meat Planet: Artificial Flesh and the Future of Food.* U of California P, 2019.
- Alkon, Paul. “Cannibalism in Science Fiction.” *Foods of the Gods: Eating and the Eaten in Fantasy and Science Fiction*, edited by Gary Westfahl and George Slusser, U of Georgia P, 1996, pp. 142–159.
- Antiviral*, directed by Brandon Cronenberg, Alliance Films, 2012.
- Ashbrook, Tom. “Margaret Atwood on Science Fiction.” *On Point*, WBUR, 12 Oct. 2011, www.wbur.org/onpoint/2011/10/12/margaret-atwood. Accessed 24 May 2021.
- Atwood, Margaret. *Oryx and Crake.* Anchor Books, 2003.
- Barthes, Roland. “Steak and Chips.” *Mythologies*, translated by Anette Lavers, Hill and Wang, 1972, pp. 62–64.
- Beckert, Jens. *Imagined Futures: Fictional Expectations and Capitalist Dynamics.* Harvard UP, 2016.
- Belasco, Warren. *Meals to Come: A History of the Future of Food.* U of California P, 2006.
- Benjaminson, M. A., J. A. Gilchrist, and M. Lorenz. “In Vitro Edible Muscle Protein Production System (MPPS): Stage 1, Fish.” *Acta Astronaut*, vol. 51, no. 12, 2002, pp. 879–889.
- Bhat, Zuhaib Fayaz, Sunil Kumar, and Hina Fayaz. “In Vitro Meat Production: Challenges and Benefits over Conventional Meat Production.” *Journal of Integrative Agriculture*, vol. 14, no. 2, 2015, pp. 241–248.
- Birkenhead, Frederick Edwin. “Save This for Your Children’s Children.” *Cosmopolitan*, vol. 86, no. 2, 1929, pp. 70–71, 176–178.
- . *The World in 2030 AD.* Hodder & Stoughton, 1930.
- “BiteLabs.” www.bitelabs.org. Accessed 29 May 2021.
- Bové, José, and François Dufour. *The World Is Not for Sale: Farmers Against Junk Food*, translated by Anna de Casparis, Verso, 2001.
- Broderick, Damien. “Reading Sf as a Mega-Text.” 1992. *Science Fiction Criticism: An Anthology of Essential Writings*, edited by Rob Latham, Bloomsbury Academic, 2017, pp. 139–148.
- Brown, Jennifer. “Remembrance of Freedoms Past: Foodways in Slave Narratives.” *The Routledge Companion to Literature and Food*, edited by Lorna Piatti-Parnell and Donna Lee Brien, Routledge, 2018, pp. 160–174.

- Caldwell, Malcolm. *The Wealth of Some Nations*. Zed P, 1977.
- Canavan, Gerry, and Kim Stanley Robinson, editors. *Green Planets: Ecology and Science Fiction*. Wesleyan UP, 2014.
- Carrington, Damien. “No-Kill, Lab-Grown Meat to Go on Sale for First Time.” *The Guardian*, 2 Dec. 2020, [www.theguardian.com/environment/2020/dec/02/no-kill-lab-grown-meat-to-go-on-sale-for-first-time](http://www.theguardian.com/environment/2020/dec/02/no-kill-lab-grown-meat-to-go-on-sale-for-first-time). Accessed 2 Dec. 2020.
- Carter, Charles. “Homebrew Meat Club: Japanese Sci-Fi Inspires Open Source Cell Agriculture.” *Engineering and Technology*, Sept. 2020, [eandt.theiet.org/content/articles/2020/09/homebrew-meat-club-japanese-sci-fi-inspires-open-source-cell-agriculture/](http://eandt.theiet.org/content/articles/2020/09/homebrew-meat-club-japanese-sci-fi-inspires-open-source-cell-agriculture/). Accessed 18 May 2021.
- Castle, Nora. “‘You Eat or You Die’: Sixth Extinction Cannibalism in Contemporary Speculative Fiction.” *Interdisciplinary Essays on Cannibalism: Bites Here and There*, edited by Giulia Champion, Routledge, 2021, pp. 42–59.
- Catts, Oron, and Ionat Zurr. “Disembodied Livestock: The Promise of a Semi-Living Utopia.” *Parallax*, vol. 19, no. 1, 2013, pp. 101–113.
- . “Semi-Living Steak.” *The Tissue Culture & Art Project*, [caproject.net/portfolio/semi-living-steak/](http://caproject.net/portfolio/semi-living-steak/). Accessed 16 Mar. 2021.
- Ceballos, Gerardo, Paul R. Ehrlich, and Rodolfo Dirzo. “Biological Annihilation via the Ongoing Sixth Mass Extinction Signaled by Vertebrate Population Losses and Declines.” *Proceedings of the National Academy of Sciences*, vol. 114, no. 30, 2017, pp. E6089–E6096.
- Cerier, Steven E. “Frankenfoods? A ‘Terrible Word’ That Could Describe More Foods than You Might Realize.” *Genetic Literacy Project: Science Not Ideology*, 13 Apr. 2018, [geneticliteracyproject.org/2018/04/13/frankenfoods-a-terrible-word-that-could-describe-more-foods-than-you-might-realize/](http://geneticliteracyproject.org/2018/04/13/frankenfoods-a-terrible-word-that-could-describe-more-foods-than-you-might-realize/). Accessed 27 Nov. 2020.
- Curstmont, Sandrine. “Make Your Own Meat with Open-Source Cells—No Animals Necessary.” *New Scientist*, 11 Jan. 2017, [www.newscientist.com/article/mg23331080700-make-your-own-meat-with-open-source-cells-no-animals-necessary/](http://www.newscientist.com/article/mg23331080700-make-your-own-meat-with-open-source-cells-no-animals-necessary/). Accessed 18 May 2021.
- Chan, Eugene Y., and Natalina Zlatevska. “Jerkies, Tacos, and Burgers: Subjective Socioeconomic Status and Meat Preference.” *Appetite*, vol. 132, 2019, pp. 257–266.
- Christou, Maria. *Eating Otherwise: The Philosophy of Food in Twentieth-Century Literature*. Cambridge UP, 2017.
- Churchill, Winston. “Fifty Years Hence.” *The Strand Magazine*, vol. 82, July–Dec. 1931, pp. 549–558.
- Cleveland, David. *Balancing on a Planet: The Future of Food and Agriculture*. U of California P, 2014.
- Cook, Katy. *The Psychology of Silicon Valley: Ethical Threats and Emotional Unintelligence in the Tech Industry*. Springer Nature, 2020.
- Cooper, Melinda. *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era*. U of Washington P, 2008.
- Davies, William, editor. *Economic Science Fictions*. Goldsmiths P, 2018.
- “Dead Stop.” *Star Trek: Enterprise*, directed by Roxann Dawson, season 2, episode 4, UPN, 9 Oct. 2002.

- Dekkers, Jack C. M., and Frédéric Hospital. "The Use of Molecular Genetics in the Improvement of Agricultural Populations." *Nature Reviews Genetics*, vol. 3, no. 1, 2002, pp. 22–32.
- Dougherty, Elizabeth. *The Blind Pig*. School Street Books, 2010.
- Doughman, Elizabeth. "Cultured Meat: From Science Fiction to Reality." *WATTPoultry. Com*, 11 Feb. 2021, [www.wattagnet.com/articles/42221-cultured-meat-from-science-fiction-to-reality?v=preview](http://www.wattagnet.com/articles/42221-cultured-meat-from-science-fiction-to-reality?v=preview). Accessed 22 May 2021.
- Edelman, P. D., D. C. McFarland, V. A. Mironov, and J. G. Matheny. "Commentary: In Vitro-Cultured Meat Production." *Tissue Engineering*, vol. 11, no. 5–6, 2005, pp. 659–662.
- Fiddes, Nick. *Meat: A Natural Symbol*. Routledge, 1992.
- François, Anne-Lise. "'O Happy Living Things': Frankenfoods and the Bounds of Wordsworthian Natural Piety." *Diacritics*, vol. 33, no. 2, 2003, pp. 42–70.
- Fudge, Erica. "Why It's Easy Being a Vegetarian." *Textual Practice*, vol. 24, no. 1, 2010, pp. 149–166.
- Galbreath, Marcy. "A Consuming Read: The Ethics of Food in Margaret Atwood's Oryx and Crake." *Florida Gulf Coast University's Second International Humanities and Sustainability Conference*, 7–9 Oct. 2010. Conference Presentation. [www.academia.edu/2284228/A\\_Consuming\\_Read\\_the\\_Ethics\\_of\\_Food\\_in\\_Margaret\\_Atwood\\_s\\_Oryx\\_and\\_Crake](http://www.academia.edu/2284228/A_Consuming_Read_the_Ethics_of_Food_in_Margaret_Atwood_s_Oryx_and_Crake). Accessed 30 July 2019.
- Gerber, P. J., H. Steinfeld, B. Henderson, A. Mottet, C. Opio, J. Dijkman, A. Falcucci, and G. Tempio. *Tackling Climate Change through Livestock—A Global Assessment of Emissions and Mitigation Opportunities*. Food and Agriculture Organization of the United Nations (FAO), 2013.
- Godfray, H. Charles J., Paul Aveyard, Tara Garnett, Jim W. Hall, Timothy J. Key, Jamie Lorimer, Ray T. Pierrehumbert, Peter Scarborough, Marco Springmann, and Susan A. Jebb. "Meat Consumption, Health, and the Environment." *Science*, vol. 361, no. 6399, 2018.
- Goodland, R., and J. Anhang. *Livestock and Climate Change: What If the Key Actors in Climate Change Are... Cows, Pigs, and Chickens?* Worldwatch Institute, 2009.
- Gordon, Joan. "Animal Studies." *The Routledge Companion to Science Fiction*, edited by Mark Bould, Andrew M. Butler, Adam Roberts, and Sherryl Vint, Routledge, 2009, pp. 331–340.
- Hanlon, Michael. "Fake Meat: Is Science Fiction on the Verge of Becoming Fact?" *The Guardian*, 22 June 2012, [www.theguardian.com/science/2012/jun/22/fake-meat-scientific-breakthroughs-research](http://www.theguardian.com/science/2012/jun/22/fake-meat-scientific-breakthroughs-research). Accessed 16 Mar. 2021.
- Hayles, N. Katherine. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. U of Chicago P, 1999.
- Hegeman, Puck D., and Roger Sørheim. "Why Do They Do It? Corporate Venture Capital Investments in Cleantech Startups." *Journal of Cleaner Production*, vol. 294, 2021.
- Ho, Solarina. "New Lab-Grown Meat More Like Steak, Better for Environment, Scientists Say." *CTV News*, 8 Feb. 2021, [www.ctvnews.ca/sci-tech/new-lab-grown-meat-more-like-steak-better-for-environment-scientists-say-1.5299941](http://www.ctvnews.ca/sci-tech/new-lab-grown-meat-more-like-steak-better-for-environment-scientists-say-1.5299941). Accessed 24 Mar. 2022.
- Hollinger, Veronica. "Genre vs. Mode." *The Oxford Handbook of Science Fiction*, edited by Rob Latham, Oxford UP, 2014, pp. 139–151.

- Hopkins, Patrick D., and Austin Dacey. "Vegetarian Meat: Could Technology Save Animals and Satisfy Meat Eaters?" *Journal of Agricultural and Environmental Ethics*, vol. 21, no. 6, 2008, pp. 579–596.
- Jiang, Lijing. *Alexis Carrel's Immortal Chick Heart Tissue Cultures (1912–1946)*. 5 Nov. 2012. [hpsrepository.asu.edu/handle/10776/3937](https://hpsrepository.asu.edu/handle/10776/3937). Accessed 28 Aug. 2019.
- Jochems, Carl E. A., Jan B. F. van der Valk, Frans R. Stafleu, and Vera Baumans. "The Use of Fetal Bovine Serum: Ethical or Scientific Problem?" *Alternatives to Laboratory Animals*, vol. 30, no. 2, Mar. 2002, pp. 219–227.
- Jones, Bryony A., Delia Grace, Richard Kock, Silvia Alonso, Jonathan Rushton, Mohammed Y. Said, Declan McKeever, Florence Mutua, Jarrah Young, John McDermott, and Dirk Udo Pfeiffer. "Zoonosis Emergence Linked to Agricultural Intensification and Environmental Change." *Proceedings of the National Academy of Sciences*, vol. 110, no. 21, 2013, pp. 8399–8404.
- JUST Egg. *Cultured Meat: A Vision of the Future*. 2018, [www.youtube.com/watch?v=f8Ii3DB6ejE](https://www.youtube.com/watch?v=f8Ii3DB6ejE). Accessed 25 May 2021.
- Kay, Jane. "Frankenfood" Protest." *SFGATE*, 14 Dec. 1999, [www.sfgate.com/news/article/Frankenfood-protest-3196995.php](http://www.sfgate.com/news/article/Frankenfood-protest-3196995.php). Accessed 27 Nov. 2020.
- Kendal, Evie. "Utopian Visions of 'Making People': Science Fiction and Debates on Cloning, Ectogenesis, Genetic Engineering, and Genetic Discrimination." *Biopolitics and Utopia: An Interdisciplinary Reader*, edited by Patricia Stapleton and Andrew Byers, Palgrave Macmillan, 2015, pp. 89–117.
- Kolbert, Elizabeth. *The Sixth Extinction: An Unnatural History*. Henry Holt, 2014.
- Lewis, Paul. "Mutant Foods Create Risks We Can't Yet Guess: Since Mary Shelley." *The New York Times*, 16 June 1992, p. 24.
- Linett, Maren Tova. *Literary Bioethics: Animality, Disability, and the Human*. NYU P, 2020.
- Marschall, Michael. "Lab-Grown Meat Now Mimics Muscle Fibres like Those Found in Steak." *New Scientist*, 2 Mar. 2021, [www.newscientist.com/article/2269671-lab-grown-meat-now-mimics-muscle-fibres-like-those-found-in-steak/](http://www.newscientist.com/article/2269671-lab-grown-meat-now-mimics-muscle-fibres-like-those-found-in-steak/). Accessed 18 May 2021.
- Mattick, Carolyn S., Amy E. Landis, Braden R. Allenby, and Nicholas J. Genovese. "Anticipatory Life Cycle Analysis of In Vitro Biomass Cultivation for Cultured Meat Production in the United States." *Environmental Science & Technology*, vol. 49, no. 19, Oct. 2015, pp. 11941–11949.
- Maughan, Chris. "'Food from Nowhere': Food, Fuel and the Fantastical." *Open Library of Humanities*, vol. 5, no. 58, 2019, pp. 1–30.
- McHugh, Nancy. "It's in the Meat: Science Fiction and the Politics of Ignorance." *SciFi in the Mind's Eye: Reading Science through Science Fiction*, edited by Margret Grebowicz, Open Court, 2007, pp. 39–56.
- McQueen, Sean. "Antiviral: Capitalism of the Fourth Kind." *Science Fiction Film and Television*, vol. 8, no. 1, 2015, pp. 29–51.
- Milburn, Josh. "Chewing Over In Vitro Meat: Animal Ethics, Cannibalism, and Social Progress." *Res Publica*, vol. 22, no. 3, 2016, pp. 249–265.

- Miller, John. "In Vitro Meat: Power, Authenticity and Vegetarianism." *Journal for Critical Animal Studies*, vol. 10, no. 4, 2012, pp. 41–63.
- . "The Literary Invention of In Vitro Meat: Ontology, Nostalgia and Debt in Pohl and Kornbluth's *The Space Merchants*." *Literature and Meat Since 1900*, by Seán McCorry and John Miller, Palgrave Macmillan, 2019, pp. 91–110.
- New Food Economy. *Is Lab-Grown Chicken the Future of Food?* 2018, www.youtube.com/watch?v=iIqeP7DQEFQ&t=1s. Accessed 12 Mar. 2021.
- Nye, Coleman. "The Matter of In-Vitro Meat: Speculative Genres of Future Life." *The Palgrave Handbook of Twentieth and Twenty-First Century Literature and Science*, edited by The Triangle Collective, Palgrave Macmillan, 2020, pp. 375–395.
- Parry, Jovian. "Oryx and Crake and the New Nostalgia for Meat." *Animals and Society*, vol. 17, 2009, pp. 241–256.
- Potts, Annie. "What Is Meat Culture?" *Meat Culture*, edited by Annie Potts, Brill, 2016, pp. 1–30.
- Potts, Robert. "Light in the Wilderness." *The Guardian*, 26 Apr. 2013, www.theguardian.com/books/2003/apr/26/fiction.margaretatwood. Accessed 24 May 2021.
- Prasad, Vina Jie-Min. "A Series of Steaks." *Clarkesworld*, no. 124, 2017, clarkesworldmagazine.com/prasad\_01\_17/. Accessed 20 Sept. 2020.
- Rifkin, Jeremy. *Beyond Beef: The Rise And Fall of the Cattle Culture*. Plume, 1993.
- Roberts, Paul. *The End of Food: The Coming Crisis in the World Food Industry*. Bloomsbury, 2008.
- Rutzerveld, Chloé. "In Vitro Me." *The In Vitro Meat Cookbook*, edited by Koert van Mensvoort and Hendrik-Jan Grievink, BIS Publishers, 2014, p. 147.
- Schonwald, Josh. "Future Fillet." *University of Chicago Magazine*, 2009, magazine.uchicago.edu/0906/features/future\_fillet.shtml. Accessed 2 May 2019.
- Sexton, Alexandra E. "Feeding the World Silicon Valley-Style: Place, Protein and Promise." 18 Mar. 2021, Microsoft Teams. Seminar.
- . "Food as Software: Place, Protein, and Feeding the World Silicon Valley-Style." *Economic Geography*, 2020, pp. 1–21.
- Shapiro, Paul. *Clean Meat: How Growing Meat Without the Animals Will Revolutionize Dinner and the World*. Gallery Books, 2018.
- . "Commentary: Science Fiction No More, Can Lab-Grown Meat Feed—and Save—the World?" *Reuters*, 26 Feb. 2018, www.reuters.com/article/us-shapiro-meat-commentary-idUSKCN1GA25H. Accessed 16 Mar. 2021.
- Simonsen, Rasmus R. "Eating for the Future: Veganism and the Challenge of In Vitro Meat." *Biopolitics and Utopia: An Interdisciplinary Reader*, edited by Patricia Stapleton and Andrew Byers, Palgrave Macmillan, 2015, pp. 167–190.
- Small, Zachary. "Steaks Grown From Human Cells Spark Interest and Outrage." *The New York Times*, 7 Dec. 2020, www.nytimes.com/2020/12/07/arts/design/Ouroboros-Steak-design-museum.html. Accessed 10 Dec. 2020.
- Smetana, Sergiy, Alexander Mathys, Achim Knoch, and Volker Heinz. "Meat Alternatives: Life Cycle Assessment of Most Known Meat Substitutes." *The International Journal of Life Cycle Assessment*, vol. 20, no. 9, 2015, pp. 1254–1267.
- Stephens, Neil. "Cultured Meat on the Menu." *In Vitro Meat: Ethics & Culture*, Google Meet. Symposium Presentation, 1 Feb. 2021.

- Stephens, Neil, Lucy Di Silvio, Illtud Dunsford, Marianne Ellis, Abigail Glencrosse, and Alexandra Sexton. "Bringing Cultured Meat to Market: Technical, Socio-Political, and Regulatory Challenges in Cellular Agriculture." *Trends in Food Science & Technology*, vol. 78, 2018, pp. 155–166.
- Stephens, Neil, Alexandra E. Sexton, and Clemens Driessen. "Making Sense of Making Meat: Key Moments in the First 20 Years of Tissue Engineering Muscle to Make Food." *Frontiers in Sustainable Food Systems*, vol. 3, no. 45, 2019.
- Stock, Paul, and Michael Carolan. "A Utopian Perspective on Global Food Security." *Food Systems Failure: The Global Food Crisis and the Future of Agriculture*, edited by Christopher Rosin, Paul Stock, and Hugh Campbell, Earthscan, 2012, pp. 114–128.
- Submarine Channel and Next Nature Network. "In Vitro Me! Love Medallion." *Bistro In Vitro*, [bistro-invito.com/en/dishes/in-vitro-me-love-medallion/](http://bistro-invito.com/en/dishes/in-vitro-me-love-medallion/). Accessed 29 Apr. 2019.
- Taylor, Sunaura. *Beasts of Burden: Animal and Disability Liberation*. The New P, 2017.
- Twine, Richard. *Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies*. Earthscan, 2010.
- "Tyson Ventures." *Tyson Foods*, [www.tysonfoods.com/innovation/food-innovation/tyson-ventures](http://www.tysonfoods.com/innovation/food-innovation/tyson-ventures). Accessed 15 Feb. 2021.
- van Mensvoort, Koert, and Hendrik-Jan Grievink, editors. *The In Vitro Meat Cookbook*. BIS Publishers, 2014.
- van Mensvoort, Koert, Alessia Andreotti, and Allison Guy. "No Future for Traditional Meat: An Interview with Mark Post." *The In Vitro Meat Cookbook*, edited by Koert van Mensvoort and Hendrik-Jan Grievink, BIS Publishers, 2014, pp. 47–51.
- Vieira, Fátima. "The Concept of Utopia." *The Cambridge Companion to Utopian Literature*, edited by Gregory Claeys, Cambridge UP, 2010, pp. 3–27.
- Vint, Sherryl. *Animal Alterity: Science Fiction and the Question of the Animal*. Liverpool UP, 2010.
- Wallace, Molly, editor. "Discomfort Food: Analogy and Biotechnology." *Risk Criticism*, U of Michigan P, 2016, pp. 93–122.
- Welchman, Jennifer. "Frankenfood, or, Fear and Loathing at the Grocery Store." *Journal of Philosophical Research*, vol. 32, Supplement, 2007, pp. 141–150.
- Williams, Rhys. "Turning Toward the Sun: The Solarity and Singularity of New Food." *South Atlantic Quarterly*, vol. 118, no. 1, 2021, pp. 151–162.
- Witkowski, Jan A. "Dr. Carrel's Immortal Cells." *Medical History*, vol. 24, no. 2, 1980, pp. 129–142.
- Witte, Wolfgang. "Medical Consequences of Antibiotic Use in Agriculture." *Science*, vol. 279, no. 5353, 1998, pp. 996–997.
- Wolfe, Cary. *Animal Rites: American Culture, the Discourse of Species, and Posthumanist Theory*. U of Chicago P, 2003.
- World Livestock 2013: Changing Disease Landscapes*. Food and Agriculture Organization of the United Nations (FAO), 2013, [www.fao.org/3/i3440e/i3440e.pdf](http://www.fao.org/3/i3440e/i3440e.pdf). Accessed 29 June 2020.
- Zider, Bob. "How Venture Capital Works." *Harvard Business Review*, Dec. 1998, [hbr.org/1998/11/how-venture-capital-works](http://hbr.org/1998/11/how-venture-capital-works). Accessed 23 May 2021.